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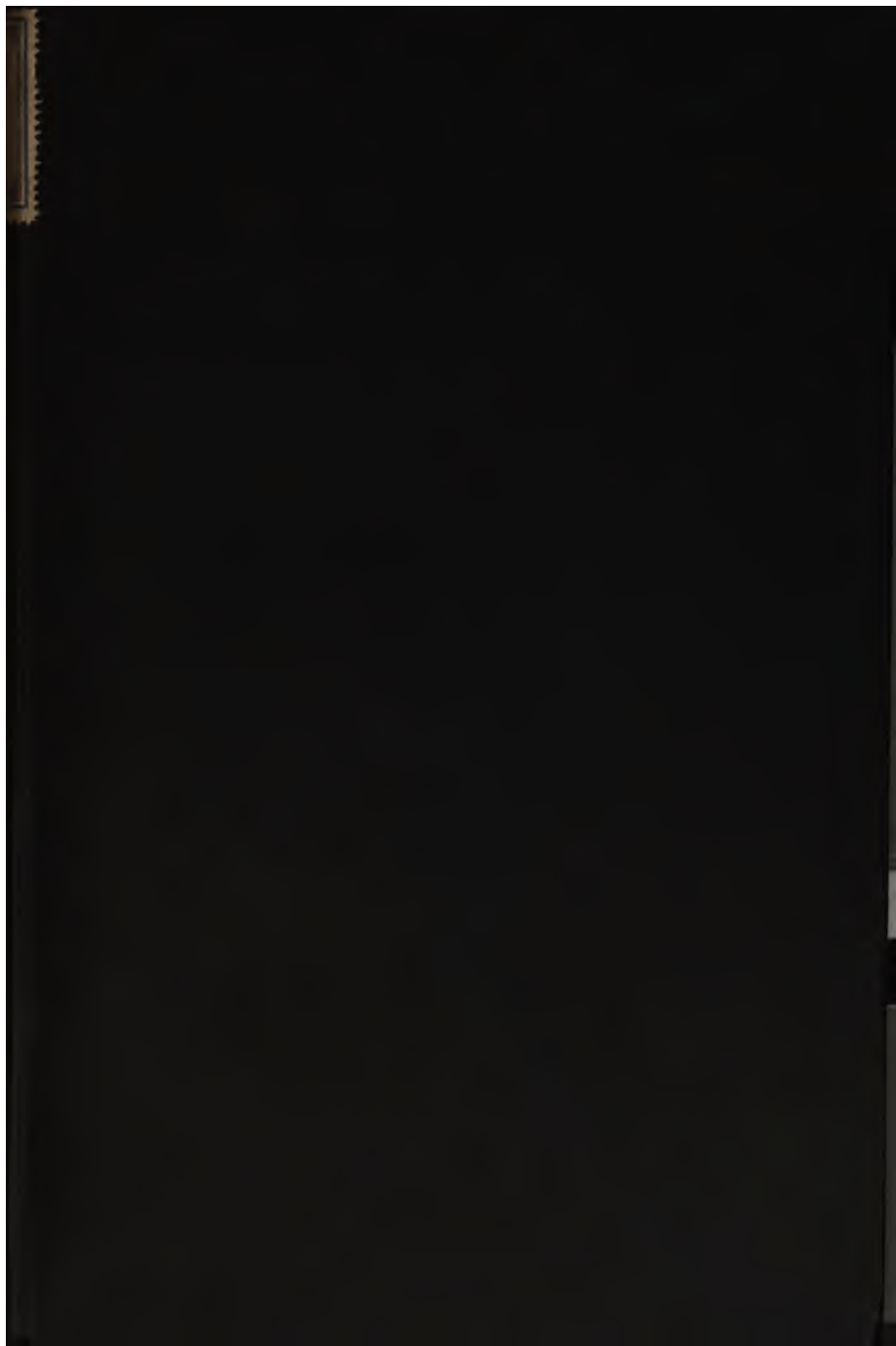
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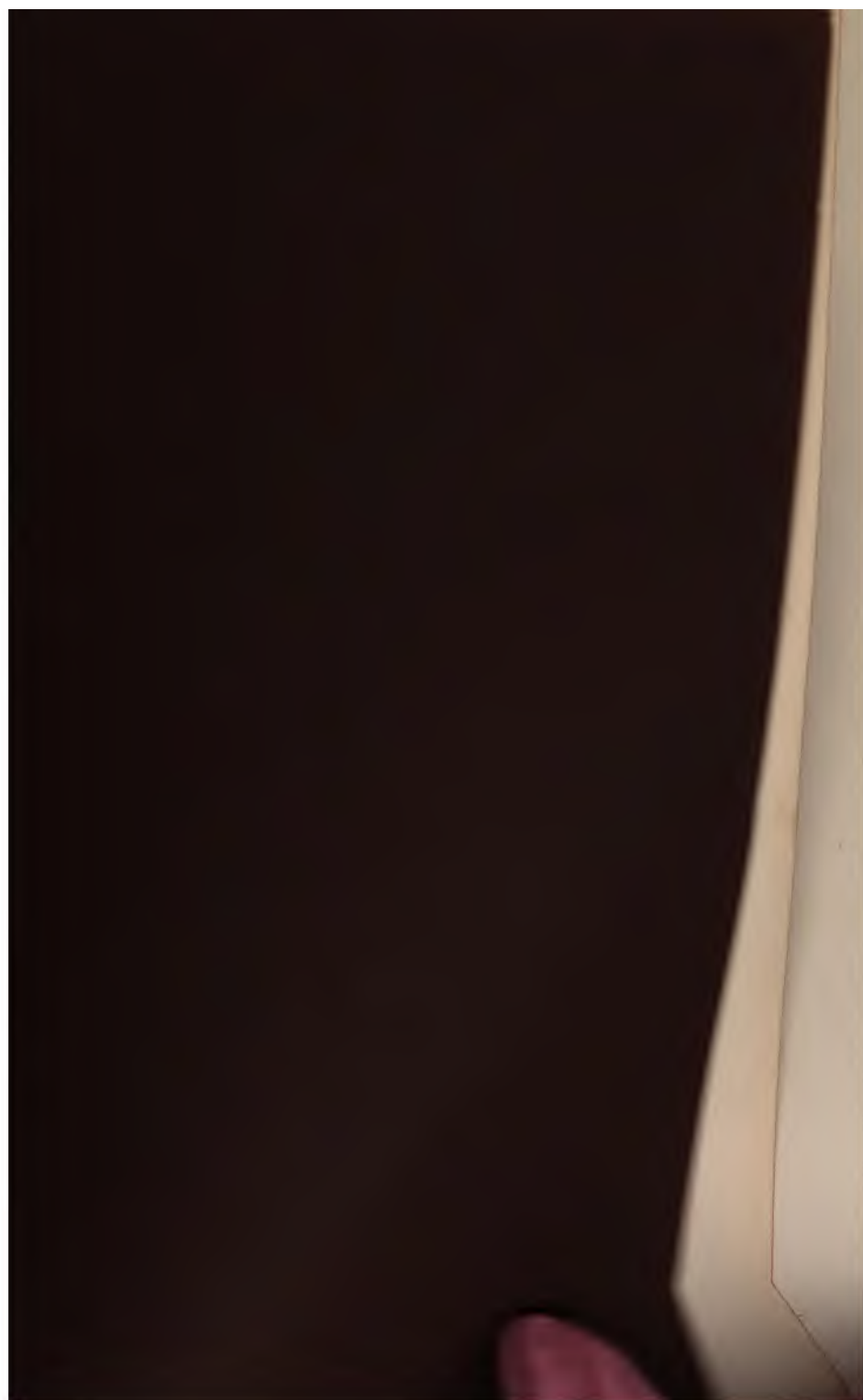
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TRACHEOTOMY
OR
LARYNGEAL DIPHTHERIA
AFTER-TREATMENT—COMPLICATIONS

BY THE SAME AUTHOR.

THE PATHOLOGY AND ETIOLOGY OF CONGENITAL CLUB-FOOT.

In active preparation.

A COMPLETE TREATISE ON THE SURGICAL DISEASES OF INFANTS
AND CHILDREN, INCLUDING DEFORMITIES.

TRACHEOTOMY
IN
LARYNGEAL DIPHThERIA
AFTER-TREATMENT AND COMPLICATIONS.

BY
ROBERT WILLIAM PARKER,
SURGEON TO THE EAST LONDON HOSPITAL FOR CHILDREN
AND TO THE
GROSVENOR HOSPITAL FOR WOMEN AND CHILDREN.

SECOND EDITION.
REVISED AND CONSIDERABLY ENLARGED.

"Un remède expérimenté vaut mieux qu'un désespoir assuré."
HABICOT.

LONDON:
H. K. LEWIS, 136, GOWER STREET, W.C.
1885.

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TO
CHARLES WEST, M.D., F.R.C.P.,
CORRESPONDING MEMBER OF THE ACADEMIE DE MEDICINE OF PARIS;
FOUNDER OF THE FIRST CHILDREN'S HOSPITAL IN ENGLAND,
AND FOR TWENTY-THREE YEARS ITS SENIOR PHYSICIAN;

UNDER WHOSE SUPERVISION MY FIRST

TRACHEOTOMY

WAS PERFORMED, AND THANKS TO WHOSE CARE
IT PROVED SUCCESSFUL;

IN RECOGNITION OF HIS DISTINGUISHED SERVICES IN THE
CAUSE OF SICK CHILDREN;

AND

IN ACKNOWLEDGMENT OF MUCH PERSONAL KINDNESS,

I RESPECTFULLY AND GRATEFULLY

Dedicate

THIS VOLUME.

PREFACE TO THE SECOND EDITION.

THE additional experience I have gained since the first edition was published has further convinced me of the correctness of the general principle which underlies the treatment advocated in this work, viz. that as a largely local disease diphtheria at all stages requires local treatment.

I have completely re-modelled the chapter on the nature and treatment of diphtheria, and have briefly discussed also the subject of infectiousness and of disinfection, in deference to suggestions, which have been made to me from time to time. The chapters which deal with the operation have all been amplified in detail, and I have added a chapter on complications—conditions which retard the restitution of the laryngeal function after tracheotomy—and given a series of cases illustrating the difficulties of diagnosis, and of the operation, the dangers and complications which sometimes follow, and the treatment appropriate to each.

At the time my first edition was published I had performed twenty-one operations for diphtheria with twelve recoveries; I have now to record thirty-two operations with seventeen recoveries. I have also seen in consulta-

tion many cases of diphtheria after operation in which this plan of treatment has proved successful.

The book is still the only one in the English language in which after-treatment is at all methodically dealt with. Even the latest surgical text-books pass over the subject almost in silence, as if it were unimportant or non-existent.

I have to thank my friend and colleague, Dr. COUTTS, for reading through the proof-sheets.

R. W. P.

8, OLD CAVENDISH STREET, W.;

June, 1885.

PREFACE TO THE FIRST EDITION.

THE primary objects of this book are two :—1. To advocate the utility and importance of local treatment in cases of laryngeal diphtheria (membranous croup) ; and 2. To give, for the use of house surgeons and practitioners, short but detailed instructions as to how such treatment may be easily carried out.

I am emboldened to publish it by the favorable reception which my paper on the same subject received from the Fellows of the Royal Medical and Chirurgical Society in the early part of the Session 1878—79. This book is to be regarded as an enlarged edition of that paper, and as containing details, which, though useful in practice, were not adapted for reading before a learned Society. I would take this opportunity of thanking the Council for allowing me to use for this book some of the woodcuts, which illustrate the paper as published in the Society's 'Transactions.'

The discussion on "Tracheotomy in Croup" at Cork, at the Meeting of the British Medical Association, 1879, still further impressed me with the belief that my book will fill an acknowledged want in our medical literature, and that it will be acceptable to those for whom it is written.

It is not a little remarkable that our English surgical text-books do not enter into the subject of the after-treatment which tracheotomy cases require ; although all make mention of the operation, and give most accurately the indications for its performance. I gladly acknowledge my indebtedness to these standard works.

There are few subjects in medicine on which we possess a larger literature than on Diphtheria and its Treatment. I have naturally availed myself of all that has come within my reach. And while anxious most fully to do justice to previous workers in this subject, I nevertheless find it exceedingly difficult to rightly adjudge to its proper author the various rules of, modifications and improvements in treatment which have from time to time been adopted. This must be my excuse for any seeming neglect in this direction.

Although I am not aware that any similar plan of treatment has been elsewhere described or advocated as a matter of routine, I have doubtless, in developing the plan, been influenced by what I have read. On this account, therefore, I make no claim to priority or originality ; for the mode in which local treatment is carried out I consider as a mere detail, while the first use of this or that instrument I regard as too insignificant a ground on which to base a claim to originality in this special subject. I shall, elsewhere, give a list of those authors, with whose works I am best acquainted, and I would now collectively thank them for much that I cannot individually acknowledge.

The plan of treatment, herein advocated, has been adopted from a growing conviction that Diphtheria, in the first instance, is a purely local disease, and as such

at all subsequent stages largely requires local measures for its eradication. So strongly do I believe in the infectiousness, as well as the mechanical danger, of the local manifestations of this disease, that—for my own better guidance, and with a view to keep well in my mind's eye the great indication for treatment—I have formulated the following dictum :—

THE PRESENCE OF MEMBRANE IN THE TRACHEA IN A FATAL CASE OF MEMBRANOUS LARYNGITIS, AFTER TRACHEOTOMY, MUST BE REGARDED AS EVIDENCE OF THE WANT OF DUE CARE ON THE PART OF THE SURGEON IN CHARGE, AS MUCH AS WOULD THE PRESENCE OF A PIECE OF GUT IN THE INGUINAL CANAL AFTER HERNIOTOMY, OR A CALCULUS IN THE BLADDER AFTER THE OPERATION OF LITHOTOMY.

I have great pleasure in acknowledging much valuable help, and many able suggestions, from my friend Dr. SIDNEY COUPLAND, of the Middlesex Hospital.

March, 1880.

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TRACHEOTOMY

IN

LARYNGEAL DIPHTHERIA.

CHAPTER I.

INTRODUCTION.

- I. *Historical Retrospect.*—*Early operators and methods*—*First use of cannula*—*Double cannula*—*Moveable collar*—*Tracheotomy without tubes the desideratum.*
- II. *General Remarks on Tracheotomy.*—*General indications*—*Contra-indications*—*After - treatment*—*Diagnosis*—*Value of early operation.*

I. HISTORICAL RETROSPECT.—Under the term Bronchotomy the operation of opening the windpipe was known to, and described by, the earliest writers. KURT SPRENGEL,¹ in his admirable history of surgical operations, gives a long bibliographical account of its origin and early history, according to which ASCLEPIADES, of Bithynia, who flourished during the time of CICERO, about 100 years before the present era, appears to have been the first to perform this operation. It seems to have been successful, for SPRENGEL, quoting CÆLIUS AURELIANUS, says, “in this manner he saved a great many persons who were in danger of perishing from suffocation.”

The operation met with considerable opposition ; among

¹ ‘Geschichte der Chirurgie,’ Halle, 1805.

others, from **ARETÆUS**, who feared that the rings of the trachea would never unite again. After an interval of about two hundred years, **ANTYLLUS** revived the operation. It, however, again fell into abeyance, and was not further practised for upwards of fourteen hundred years, when **BENIVIENI**, of Florence, operated for what seems to have been dyspnoea, produced by a retro-pharyngeal abscess.

FABRICIUS (ab Aquapendente) gives the first detailed account of the method of operating. **JULIUS CASSERIUS**, a pupil of **FABRICIUS**, gives a still more detailed account, with drawings of the instruments necessary and of the incision into the trachea. **LAURENCE HEISTER** (who flourished in the early part of the eighteenth century) was an active partisan of the operation, and described its mode of performance and its indications with considerable minuteness. The operation from this time onwards seems to have become naturalised in surgery; it was advocated and performed by all the principal surgeons from this date down to our own times.

Surgeons have always considered the operation a difficult one, and it was this circumstance which induced **SANCTORIUS** (1586) and **DEKKERS**, a Dutch surgeon (1694), to propose the use of a tracheotome instead of the scalpel which had ordinarily been used. This tracheotome was not unlike our well-known trocar and cannula; it was plunged into the trachea just as into the abdomen. In 1832 Mr. Wood¹ expressed himself in favour of this instrument: "With a slight modification of **DEKKERS'** instrument, his mode of operating might, perhaps, in some cases be renewed with advantage. This plan is calculated to obviate the danger of hæmorrhage into the

¹ 'Medico-Chirurgical Transactions,' vol. xvii, p. 138, *et seq.*, "On Bronchotomy." The instrument is figured; it is constructed on similar principles to Mr. Durham's well-known 'lobster-tail' tubes.

air-passage and the vexatious and mischievous delay it may cause. Besides it enables the operator to accomplish his purpose without the assistance of another person. The proposed alteration consists in substituting a curved silver tube for the straight cannula, and in having part of the shaft of the trocar formed of conjoined links." Sundry other tracheotomes—some very ingenious—have been proposed since, but none of them has ever been widely used. It seems probable that the earliest surgeons did not use any cannula after opening the trachea; at all events, there is no account of them; and I am unable to state by whom they were introduced. FABRICIUS used a short, straight tube. CASSERIUS preferred them slightly curved. HABICOT, somewhat later, returned to the straight tube.

Perhaps the most important change as regards the tubes was the introduction of the double tube in 1730. This is due to Dr. GEORGE MARTIN, and is recorded in the thirty-sixth volume of the 'Philosophical Transactions,' p. 448. The author is giving "An account of the operation of Bronchotome." The case seems to have been one of laryngeal diphtheria: the operation was completely successful, the cannula being removed on the fourth day. He says, "I cannot but think it an ingenious proposal of one of our ministers here to make the pipe double, or one within another; that the innermost might safely and easily be taken out and cleaned when necessary without any molestation to the patient. . . ." Of hardly less importance was M. ROGER's adoption of LÜER's proposal to have the tube attached to a moveable collar, thus permitting it to follow the movements of the larynx. The great *desideratum* of being able to dispense with a tube altogether seems as far from its realisation as when WALTHER,¹ many years ago, decried the use of every kind

¹ 'Graefe and Walther's Journal,' vol. ix, p. 204.

of cannula, as being foreign bodies and likely to increase the difficulties they were used to palliate. To the best of my knowledge, however, no efficient substitute for them has at present been found. Mr. CARMICHAEL's proposal to remove a circular piece of trachea has, fortunately I think, not been generally adopted.

It has been proposed by one author to substitute for the knife, caustics; by another, the actual cautery; by another, the galvano-cautery; by another, a heated scalpel. In each case, it was hoped thus to avoid hæmorrhage or to lessen its amount. M. CHASSAIGNAC proposed to plunge the scalpel directly into the trachea without preliminary incision. Other surgeons incise the skin and then plunge in the knife; though admirable and even necessary under some circumstances, the usual and more deliberate operation is to be commended to any but very experienced operators.

Of all the many writers on the subject of tracheotomy, there is one more especially whose name stands pre-eminent. I refer of course to TROUSSEAU. It was through his example and teaching that the operation became popularised, and it is to him that we are indebted for the most important improvements that have been made, both in the operation itself and in the methods of after-treatment.

II. GENERAL REMARKS ON TRACHEOTOMY.—The operation, never a very easy one, is sometimes very difficult, and has oftentimes to be performed under conditions little adapted to facilitate its carrying out. Probably more deaths occur during this than any other surgical operation; nor is this the surgeon's fault, for the diseases requiring the operation implicate a most vital function, and patients come under observation often only when all other resources have failed. It is an operation, moreover, most frequently required for children, in whom the

shortness of the neck and the great vascularity of the parts concerned add seriously to the difficulties.

The diseases or accidents for which tracheotomy has been performed are many and various. Foreign bodies in the trachea, and angina, were the earliest indications. Subsequently it was proposed in cases of drowning, with the double object of drawing water out and forcing air into the lungs. Dr. MARSHALL HALL proposed it in cases of spasm of the glottis during an epileptic seizure; it has been practised also during tetanic spasm. Further, intralaryngeal growths may necessitate the operation; as also tumours in the neighbourhood of the trachea, which, either by displacing it, or by pressing upon it, or by paralyzing the nerves which control the opening of the glottis, interfere with the free and easy entrance of air into the lungs.

I need hardly add that there is no hard and fast line of "after-treatment," or that the latter will depend on the primary lesion which has necessitated the operation, rather than on any peculiar condition which the operation itself introduces. For the after-treatment of a simple tracheotomy, undertaken, for instance, for the removal of a foreign body recently lodged in the windpipe, is of the simplest kind. Complications are very uncommon, and a large majority of the cases quickly recover. On the other hand, when the operation is undertaken to relieve a symptom or a consequence of disease, we still have to grapple with that disease; the which, if unrelieved, may be fatal. The operation has usually but little to do with the fatal issue.

Thus our after-treatment will vary immensely, and must always be considered in reference to the primary disease. If the operation has been called for in order to remove a foreign body, the wound may be allowed to close immediately after the foreign body is extracted. If the

operation is indicated on account of paralytic closure of the glottis, we must cure the paralysis before the tube can be finally removed, or our patient will not be benefited. If pathological new growths or foreign bodies are present they must, if possible, be removed. If temporary spasm of the glottis has threatened life, the operation will avert the danger, and as spasm cannot persist long, neither need the trachea remain long open.

As regards the operation itself, it may be enunciated broadly, and whatever be the nature of the circumstances, that tracheotomy is indicated in all cases of increasing and persistent dyspnœa, which are due to mechanical obstruction in the larynx or adjoining part of the trachea.

Are there any contra-indications ? Can a child be too young ? Or can it be too far gone ? As regards age, SCOUTETTEN successfully operated on his own child at the age of six weeks in the last stage of croup. The number of successful operations in children under two years is nevertheless comparatively small ; it is yet large enough (and increasing) to show that success is possible and that age alone is not a contra-indication.

Can the disease have progressed so far as to justify a surgeon in refusing to operate ? This is a question which I will not venture to answer for others ; but in any case where mechanical obstruction in the larynx leads to laboured breathing, I hold that tracheotomy will prove beneficial to the patient ; it will prolong life even if it does not save it, and it will deprive death of many of its terrors by relieving that sense of strangulation, which is absent even in the worst cases of pneumonia, when the larynx is free. Dr. WEST remarks, " Many of the deaths after tracheotomy are, strictly speaking, far from being instances of failure " (op. cit., p. 464).

Laboured breathing is to be carefully differentiated from frequent breathing; the former indicates mechanical hindrance to the entrance of air into the lungs, the latter that a portion of lung is *hors de combat*. Tracheotomy will relieve the one but not the other condition. TROUSSEAU says the operation is most likely to succeed "when the local lesion—when croup constitutes the principle danger of the disease" (op. cit., p. 427).

The problems for the surgeon to solve are:—1st, what are the symptoms by which laryngeal obstruction may be diagnosed; and 2nd, at what stage should an operation be undertaken. The most reliable symptom—and one which is common to all forms of laryngeal obstruction—is recession of the soft parts of the anterior chest wall during inspiration. Thus whenever we see that the epigastrium, the supraclavicular spaces, the suprasternal notch, and the intercostal spaces forcibly retract during inspiration, we may feel quite sure that there is serious mechanical obstruction to the entrance of air into the chest. And if, together with this recession, there is more or less alteration or suppression of voice, then not only is the symptom the more serious, it is, further, an indication that the obstruction is situated in the larynx.

It is not easy to specify the exact moment that an operation ought to be done. If the dyspnoea is very intense—other remedies having failed—there is then no choice but to operate. The question, however, is, should we let our patients get to this stage before we operate? The well-recognised tendency of laryngeal diphtheria to spread to the lung and the serious nature of this complication when once set up are strong arguments in favour of an early operation.

CHAPTER II.

DIPHTHERIA.

Definition—Not a new disease—Synonyms—The materies morbi—Individual predisposition—Epidemic and sporadic diphtheria—Intensity of poison variable—Pathological anatomy—Local differences—Symptoms—Mode of onset—Diphtheritic paralysis—Prognosis—Treatment—Dangers of antimony—Value of local treatment—Diet—Preventive measures—Duration of infectiousness—Disinfection.

I do not intend to discuss at any length the etiology or the pathology of diphtheria ; but I think that a summary of the chief points in its clinical history will make this essay more complete and will render the purpose of tracheotomy, and what it is able to accomplish, more obvious, while it will help to explain the *rationale* of the after-treatment advocated in the following pages. The disease has existed for centuries, and its varying manifestations have been accurately described from time to time by many authors under some one of the following (among other) terms: 'membranous,' 'malignant,' 'erysipelatous,' 'gangrenous' angina: 'spotted throat,' 'putrid sore-throat,' and 'croup.' Among these descriptions, one of the best is that by Dr. JOHN FOTHERGILL, published in 1748 ; this book contains an admirable account of diphtheria: in it he anticipates BRETONNEAU

and many subsequent observers in not a few valuable remarks on the nature and peculiarities of diphtheria.

DIPHTHERIA may be defined as an acute local inflammation, due to a specific contagion and characterised by the deposit of a fibrinous membraniform exudation upon the surface attacked, which is either mucous membrane or abraded skin, and which is very usually followed by symptoms of general blood-poisoning. The term, in this country at least, is used almost exclusively for the disease as seen in the naso-pharynx, where it most frequently commences, and in the air-passages.

Etiology.—The disease is the direct result of an infectious virus, and at first is a purely local lesion. "The virus precedes and underlies the anatomical change;" once established it spreads by the contagion of its own secretion, and it is largely in consequence of the absorption of this same morbid product that the system gradually becomes invaded. Occasionally, however, in times of epidemics and in some individual cases the local manifestations appear simultaneously with symptoms of profound blood-poisoning, the latter even outweighing the former. As to the original source of this *materies morbi* nothing is at present known. By some it is thought that, under favorable conditions of soil and atmosphere, it may originate *de novo*; its apparent sources are foul air and foul water—"though whether as mere carriers of contagion cannot be determined." Diphtheria occurs at seasons when diseases, which are called zymotic, such as measles, scarlet fever, and typhoid fever, prevail, and it is not infrequently associated with one or other of them in the same individual. Although it has not yet been possible to isolate the special organism which gives rise to the

disease and demonstrate it under the microscope, yet the evidence in favour of such an origin, it seems to me, is daily becoming more conclusive. It is true that Dr. OERTEL, of Munich, long ago described certain vegetable organisms as being present in diphtheria which he regarded as the very essence of the disease. SENATOR, of Berlin, on the other hand, teaches that these same organisms may be found in simple stomatitis. English pathologists, however, and notably Dr. BEALE, have not yet been able to satisfy themselves of the truth of this etiological connection. So far as I know, up to the present time, even with the improved methods of research, no specific organism has been found.

Beyond the peculiar manifestations to which the virus gives rise, little is known about it: it spreads from patient to patient, occurring sometimes sporadically, at other times as an epidemic. The predisposition which certain individuals and families evince towards the disease is sometimes quite remarkable, and should never be lost sight of by the surgeon in dealing with the disease. One attack does not protect the system from a second: in this respect it resembles measles or scarlet fever, one attack of which only gives partial immunity, although second attacks are the exception. No season of the year is free from it, but it is most common during cold wet weather. BRETONNEAU used to teach that the specific character of the diphtheria inflammation, like that of smallpox, only lasts about ten days, after which it gradually assumes the type of an ordinary inflammation; a doctrine which largely underlied his local plan of treatment. The occurrence of the exanthemata seems to favour the incidence of the poison, or predisposes the system to its influence; hence their frequent association. Scalds of the pharynx and air-passages, the action

of corrosive fluids, of heated air, incised wounds, the impaction of foreign bodies, and even common catarrh are determining factors of considerable importance.¹

In hospital wards, even in which there is no known or obvious source of infection, patients suffering from low depressing disorders are, not infrequently, attacked by this disease; its onset under such circumstances always calls for a grave prognosis; on the other hand, the disease shows little tendency to spread to other patients. The period of incubation is not accurately known. Some patients appear to become affected a few hours only after exposure to infection; in others the disease does not manifest itself for eight days (BRISTOWE). The true period probably varies between these dates.

Although generally of a highly contagious nature, diphtheria most frequently occurs as a sporadic disease in this country. I cannot quite accept the dictum of Dr. WEST, my friend and teacher, that it is "essentially a disease of early life," for I see almost as many cases in adults as in children, and moreover some of the best treatises we possess on the subject concern the disease as seen in adult life; nevertheless children are particularly susceptible to its influence. This sporadic occurrence of diphtheria, especially in the houses of the poor, is a very curious fact in the life-history of the disease. I can only explain it on the supposition that the receptivity to the poison becomes lessened by constant exposure to unsanitary surroundings. Whatever be the explanation, however, it is abundantly evident that the intensity of the poison varies im-

¹ A case of diphtheria following a scald is recorded by me in vol. viii (1875), 'Clinical Society's Transactions.' A similar case is recorded by Mr. Davies-Colley, vol. xxxiii (1882), 'Pathological Society's Transactions;' and Dr. Carrington records a case of diphtheria from impaction of a nutshell, *ibid.*, vol. xxxii (1881).

mensely both as regards its capacity for producing lesions and in its power of reproduction. Apparently from the same source of poison, I have more than once seen produced pharyngeal diphtheria, laryngeal diphtheria, follicular tonsillitis, and slight (non-membranous) ophthalmia in different individuals, notwithstanding that precautions were taken ; on the other hand, what a large number of cases of complete exemption in the midst of infection could be recorded !

Pathological anatomy.—The pathological products of the diphtheritic virus vary greatly both in character and extent. Mainly owing to the greater amount of sub-mucous tissue the false membrane is much more adherent in the pharynx than in the larynx, whilst in the trachea and bronchi it is readily separable, indeed it often appears quite detached. The membrane is "sometimes as soft as cream, sometimes resembling wash-leather" (JENNER). These differences are possibly dependent on the sthenicity of the disease ; thus, in 'croup' (in the old sense of the word) the membrane is generally tough and white, while in diphtheria it is most frequently softer and of an ashen-grey colour. As it approaches the lungs the membraniform quality of the exudation generally becomes less marked and assumes the character of a thick muco-pus. Nevertheless real membrane may occasionally be found even in the smallest bronchi. Microscopically, the false membrane consists of altered epithelial scales, granular corpuscles, and wandering cells, all held together by a greater or less quantity of fibrillar tissue. Micrococci, often more than one variety, are most usually present. This membrane is quite insoluble in water, but readily dissolves in weak solutions of the alkalies.

The condition of the mucous membrane differs

greatly. Sometimes, after removal of the false membrane, no appreciable breach of surface is found ; at other times there is a condition bordering on gangrene ; between these two extremes almost any gradation may be met with. The amount of swelling of the mucous membrane depends on the amount of submucous tissue, and is due to its infiltration with leucocytes and to the distension of its vessels with blood. The swelling not infrequently occludes the posterior nares, while very commonly the tonsils swell up to twice their natural size ; the ary-epiglottic folds, as well as the epiglottis and upper part of the larynx, share in the process, which I regard as a very integral part of the disease. The vocal cords are less frequently affected, and in the trachea too there is much less swelling, because the submucous tissue in these regions is less thick than in the pharynx. Studded over this swollen and congested surface will be seen islands of false membrane ; in the pharynx it generally adheres with some tenacity, in the larynx it peels off with the greatest ease. After its removal the mucous membrane in some cases hardly presents any breach of surface, while in other cases a deep excavation with a pus-covered irregular floor will be seen. Sometimes there is quite a sloughy character in the sore, which tends rapidly to spread unless actively dealt with. The tonsils, the posterior surface of the soft palate and uvula, the under surface of the epiglottis are favourite positions for the deposit of membrane. The pouch between the larynx and pharynx at the base of the tongue (*hyoid fossa* ; *sinus pyriformis*) is another very favourite spot ; in all these places the membrane accumulates from being so inaccessible.

The lymphatic glands about the neck, and those below the jaw, will be found enlarged. In a few malignant cases they will be found suppurating. I have also

found sloughing in the peri-glandular cellular tissue, the glands themselves apparently not being involved in the process. A condition of cellulitis of the neck (*Angina Ludovici*) is quite an exceptional complication at this stage, though not uncommon after tracheotomy.

The lungs constantly suffer, the disease passing down the trachea, which is then always markedly inflamed. At first, the increased secretion, by partially blocking up the bronchi, leads to surface emphysema, and subsequently to collapse in patches: then islands of lobular pneumonia centring round bronchi will be found scattered throughout the lungs. Pleurisy, with or without effusion, is common; generally it is of the dry variety, and caused by the contiguous pulmonary inflammation. The pericardium is found to contain fluid in some cases; the substance of the heart-muscle is friable and granular. In severe cases, ecchymoses will be found beneath the serous membranes. The kidneys are often free from naked-eye changes; sometimes they are large and pale: the microscope has failed to discover any constant pathological condition.

Symptoms and mode of onset.—The mode of onset varies greatly in different individuals, even in those who have been infected from the same source, thus showing the personal element in each case. Among children the early symptoms are obscure, often quite negative; loss of appetite and of playfulness, with lassitude and perhaps a little rise of temperature, are among the earliest signs that something is going wrong. If the pharynx be examined, probably only a congested condition of the fauces and tonsils will be observed. Later on small patches of membrane will be seen scattered about, on the tonsils, uvula, and soft palate, and more rarely on the cheeks also; the patches spread to neighbouring parts, "almost like a

liquid which is effused," as BRETONNEAU described it, and then coalesce: until the whole of the pharynx is completely covered. The voice will gradually assume a pharyngeal quality, which will speedily draw attention to the throat, if it should hitherto have escaped: there may also be difficulty in swallowing. In a few cases, the posterior nares being chiefly implicated, there will be a discharge from the nostrils, which will quickly cause excoriation of the nose and upper lip. The glands at the angles of and beneath the jaw will become swollen and tender, and by this time there will be little doubt as to the nature of the complaint. In the majority of cases there is foetor with the breath; its intensity depending on the severity of the disease and varying with other circumstances; diphtheria of the gums, however, is particularly foetid. Meanwhile the lassitude develops into prostration; the patient assumes a careworn, anæmic appearance. The severity of the symptoms varies immensely; sometimes the prostration and asthenia are extreme, and the patient dies straight off; in other cases danger only threatens when the disease spreads to the air-passages, in which case the symptoms will vary with the part affected. Pulmonary disease and albuminuria, about which there is nothing special to remark, will not be referred to here, and laryngeal diphtheria will be described separately. The tendency to asthenia is a feature of the disease which, though it is sometimes absent, should always be kept in mind; even in favorable cases it may come on unexpectedly, and be severe enough to cause sudden death. Whether it belongs to the same class of effects as diphtheritic paralysis, I am unable to say. In many cases of the latter disease, however, cardiac irregularities, slowing of the pulse, and weakness are often prominent symptoms.

DIPHThERITIC PARALYSIS.—As a complication—and by some considered pathognomonic of the disease—diphtheria is occasionally accompanied and followed by a peculiar form of paralysis, the exact nature of which is most obscure. It is not a little remarkable that BRETONNEAU never alludes to this complication in his work on Diphtheria published in 1825, nor in any of his previous memoirs on the same subject. It was not until 1843 that BRETONNEAU recognised the connection, and only in 1855 that it became generally acknowledged. In this country, Sir WILLIAM GULL was the first to draw attention to the subject in the ‘Lancet,’ 1858, in a paper entitled “Lesion of the Nerves of the Neck, and of the cervical segments of the cord after Faucial Diphtheria.” Soon after this a variety of theses, papers, and cases was published, among the most interesting and valuable of which must be mentioned a paper by Dr. HERMANN WEBER.¹ The earliest mention of the disease, however, is to be found in the ‘Account of the Sore-throat attended with Ulcers,’ by Dr. FOTHERGILL. Quoting from AETIUS CLETUS² (p. 14) he says :—“The consequences of this disease were often felt a long time after it had ceased ; an excessive languor and weakness continued for many months ; and the voice or deglutition was frequently affected so as to be perceivable in some almost a year after.”

This paralysis stands in no direct relation to the severity of the diphtheria ; it attacks all ages, and while several members of a family may have suffered from diphtheria, perhaps only a single one will subsequently develop paralysis. I have known it occur after “sore-throat” of so

¹ “Ueber die Lähmungen nach Diphtheria,” Virchow’s ‘Archiv für pathologische Anatomie,’ vol. xxv, 1862, and vol. xxviii, 1863.

² ‘De Morbo Strangulatorio,’ Romæ, 1636. I regret not to have been able to procure the original treatise.

mild a character that its probable nature was only first suspected when the paralysis had developed itself. In my own practice the paralysis has invariably been found to have followed the milder forms of diphtheria, and has sometimes been the first symptom noticed. Is a possible explanation to be found in the lack of treatment which mild cases get, and can the vigorous local treatment, which BRETONNEAU always enforced and practised, be credited with the non-occurrence of paralysis in his earlier records? Personally, I have never seen paralysis supervene in any case in which I have performed tracheotomy, nor do I remember to have seen it occur in any case treated in hospital from the first onset.

Mode of onset.—In a short, but able paper,¹ to which I would refer the reader, Dr. ABERCROMBIE describes very fully eighteen personally observed cases: he says, “The onset of the disease is always gradual and insidious, and it is difficult, therefore, to fix, with any degree of accuracy, the earliest date at which the paralytic symptoms commenced. . . . In fourteen of the cases the earliest symptom was either nasal voice, return of fluid through the nose, or some difficulty in swallowing; in the remaining four, weakness in the legs was the first thing noticed. . . . the only constant symptom was paralysis of the soft palate. . . .” I can quite confirm the views from my own practice. Next in frequency to the palate come the ocular (accommodation) muscles, then follow the muscles of the lower and upper extremities. The bladder, sphincters, and respiratory muscles occasionally suffer, and in a few exceptional instances complete paraplegia may result; in others, again, ataxia. GERHARDT, BUZZARD, and others have noted more or less anæsthesia. In paralysis of the limbs,

¹ ‘Transactions of the International Medical Congress,’ 1881, vol. iv, p. 61.

groups of muscles or a single muscle of a group may be affected, more rarely the entire limb. The trunk muscles are only seldom affected. Another uncommon nervous phenomenon is loss of smell; the nasal element of taste—by which I mean the perception of flavours by taste—is likewise lost in these cases. As a temporary condition I have seen this in several cases, and in one at least, as a permanent condition.

Pathological anatomy.—The exact pathology of this affection is not yet understood. In seven of the nine cases which proved fatal, Dr. ABERCROMBIE examined the medulla and spinal cord methodically, and the only pathological changes he found, consisted in a swollen condition of the large motor cells of the anterior cornua; their margins were ill defined, and the processes had in most instances entirely disappeared. The cell-contents were granular, and the nuclei had disappeared. These changes occurred in limited areas. At a later stage, the cells appeared shrunken rather than swollen. No lesion of the white matter of the cord was recognised. The medulla oblongata did not present any lesions. Other observers have described more advanced, in fact destructive changes, in these cells.

That the muscles of the pharynx and of the eye suffer most frequently, and that sensation is sometimes affected are facts, it seems to me, which point to the insufficiency of the theory that the essential lesion lies in the spinal cord. Moreover, in severe cases, and even after long intervals, recovery, when it takes place, is full and complete, a fact which is incompatible with destructive changes in the ganglionic cells in any part of the nervous system.

Prognosis.—“Even in the mildest attack of diphtheria,” says Dr. EUSTACE SMITH, “we must be guarded in

the expression of our opinion as to the probable issue of the illness." True, in general diphtheria, this remark applies with special force to the laryngeal form of the disease. For, in the latter, we have to reason with disease in a vital organ, which may kill by its mere presence, or by its septic effects on the system at large, chiefly on the lungs. Surgical operation can generally ward off the former danger, but no treatment has yet been discovered capable of preventing the latter. Dr. SMITH's caution ought to be born in mind in all cases where tracheotomy has been performed, for the relief, which at first follows, is sometimes so great as to make us forget that the disease itself is in no way influenced by the operation, and that unless vigorously followed up, it will almost certainly spread and prove fatal.

As regards the paralysis, the prognosis is very hopeful; if death do not result directly from paralysis of some vital organ—and this generally occurs early on in the disease if at all—the patients usually recover. Sometimes a year or more may elapse, but complete recovery finally occurs.

TREATMENT.—As regards internal remedies little need be said, for there is no hard and fast line of treatment; each symptom must be combated as it arises. If there is much depression, carbonate of ammonia with senega or bark (and a little glycerine to make it palatable) will have good effect. Quinine is valuable in all stages of the disease; it may be combined with the perchloride of iron or given alone. Some authors regard iron as the remedy; but in young children, I think, it is apt to disagree, if pushed too far. In the earlier stages of the disease there is sometimes a tendency to laryngeal spasm, then

bromide of ammonium will be found useful ; if severe it may be relieved by a few whiffs of chloroform, and the quietness thus produced will enable the surgeon to get a more accurate knowledge of the amount of real mechanical dyspnoea with which he has to deal.

In deciding on treatment, we must be guided not only by the general symptoms in any given case, but also by our experience of former cases. It is well known that all forms of diphtheria tend to the production of asthenia, and hence our treatment of a case, however slight it may appear to be, must be such as will help to ward off this danger.

For this reason I do not regard with favour the use which is, even now, too frequently made of antimony in the early stages of the disease. I especially object to its repeated and continued use. Not infrequently children have been reduced to a state of exhaustion by this drug, from which it has been impossible to rouse them. I would not say that antimony is always and absolutely contra-indicated ; but I think it should be restricted to one or two doses, and that it should only be given in the most sthenic forms of the disease. Its only beneficial action is that which is common to all other emetics, viz. a purely mechanical one, detaching the membranous exudations by the retching and vomiting to which it gives rise.

Antimony, moreover, in cases of diphtheria frequently fails as an emetic ; probably the carbonic acid poisoning and the constitutional depression together prevent the physiological action of the drug and meanwhile the disease progresses unhindered. Then after tracheotomy has once more re-established the vital function, the ingested antimony commences to be absorbed, and to produce the baneful influence which it so largely possesses. Much

subsequent diarrhoea and loss of appetite are probably due to it.

No doubt emetics have rendered good service in some cases ; and their use ought certainly not to be lightly spoken of. It is, however, well to select those which act as emetics only. I believe sulphate of copper is as good as any if not the very best. It is rapid in its action, and the local effect on the pharynx is not without its value. Dr. SYDNEY RINGER, in his work on 'Therapeutics,' says, "A good way to give this salt as a vomit is to administer it in small and frequently repeated doses. It generally produces one copious evacuation, neither purging, nor producing nausea or prostration."

If the disease commence primarily in the pharynx the local application of strong hydrochloric acid, as recommended by BRETONNEAU, is of great service. The acid should be diluted with twice its bulk of glycerine, and applied very freely once or twice at intervals of twelve to twenty-four hours according to circumstances. I am not able to say how it acts, whether it merely substitutes a simple for a specific inflammation, as BRETONNEAU taught, or whether it destroys the microphytes which OERTEL, among others, regards as the source and essence of the infection ; but of this I am convinced, that it is a most efficacious application.

It is, however, too powerful for frequent use, on the other hand it is very essential to constantly swab out the pharynx in order to get rid of the secretions, which accumulate fast. These secretions are very infective moreover, and they involve in the disease neighbouring parts with which they may come in contact. Glycerine of borax,¹ or of boracic acid, is one of the best applications we can

¹ See Dr. GOODHART's paper on this subject, 'Clinical Society's Transactions,' p. 38, vol. xvi, 1883.

use, besides being antiseptic it is non-irritating, and if swallowed does not upset the stomach; it may be applied with a large soft brush every hour, or in severe cases every half hour, until the pharynx assumes a more healthy aspect. Some prefer tincture of the perchloride of iron others solutions of nitrate of silver. Glycerine of carbolic acid or of alum are also advocated. I do not think the material used is a matter of first importance, it is rather the manner in which it is used, and the thoroughness with which the infective products of the local lesion are got rid of, to which I should trust in any given case.

That the secretion from a diphtheritic surface is peculiarly acrid and irritating, may be guessed by the excoriation of the anterior nares and upper lip seen in cases where the nasal mucous membrane is much affected. In such cases, either in addition to or instead of these applications (which cannot be so effectually applied to the posterior nares, as to the pharynx), irrigation as recommended by JACOB of New York, among others, will be found most valuable. In severe cases I have not hesitated to anæsthetise the child in order to save struggling and subsequent exhaustion and to be sure of the thorough removal of all the discharge. A warm solution of carbolic acid, or of boro-glyceride, or of creasote, or of sanitas or some other disinfectant, may be used, or a simple solvent such as a warm solution of potash. The tube of the irrigator is inserted into one nostril while the child's head is held forward and downwards, and from one pint to two pints of the fluid are passed through, the course of the current being changed two or three times. If the head is held properly, the fluid passes in at one nostril and out at the other. BRETONNEAU used to lay great stress on the value of local treatment both in pharyngeal and in nasal

diphtheria. In the latter he recommended the injection of a strong solution of nitrate of silver. "I have always found," he says, "local applications efficacious when I have been able to carry them over the whole extent of the diseased surface."

TROUSSEAU taught that mercurial preparations, whenever they could be applied locally, modified most powerfully the diphtheritic inflammation, and for this purpose he used calomel and the red precipitate. The old formula 'mel cupratum' (Egyptian ointment) is another powerful disinfectant and alterative. I have not sufficient experience in their use to speak with confidence of these applications.

Various disinfectants may be sprayed into the throat also. In cases where the fœtor is very pronounced, solutions of carbolic acid or sulphurous acid may be used with advantage. Solutions of carbonate of soda, or of borate of soda, will also be found of great service for cleansing the mouth. The patient may be advantageously allowed to inspire some of the spray (*vide* Fig. 14, p. 68); for this will lessen the tendency of the disease to spread. As soon as the first symptoms of laryngeal complications come on, the patient should be put into the 'croup-bed' (*vide* p. 62) and made to breathe a warm, moist atmosphere, containing either creasote, or carbolic acid.

DIET.—The importance of careful feeding during all stages of this disease can hardly be over-estimated. I have discussed the subject in another chapter (p. 73) and would refer the reader to that place; what I have said concerning the diet after operation applies equally well before. I feel convinced that the sequelæ of diphtheria would occur less frequently than they do if more attention were given to this subject.

PREVENTIVE MEASURES.—Dr. LEWIS SMITH says: "The diphtheritic virus, like the scarlatinous, may remain for

weeks or months in a locality, or in apartments, notwithstanding the use of the ordinary disinfecting and sanitary measures." Whenever diphtheria, or, indeed, any kind of zymotic disease, is prevalent, indisposition on the part of a child should at once arrest attention ; the fauces should be examined repeatedly. When diphtheria occurs in a family, not only is prompt isolation of the affected child from the other children imperatively indicated, but the fauces of these children should be examined from time to time and precautionary measures of treatment adopted on the slightest appearance of any affection. As I have already said, there is abundant evidence that certain families have a strong predisposition to be attacked by the poison. In view of such a contingency, strict isolation should always be practised, and a careful search made for the origin of the infection that it may be thoroughly and radically removed. A free use of disinfectants should meanwhile be made in the house. One of the most effective and most simple is the burning of sulphur. A few grains of powdered sulphur may be thrown on to a heated iron and allowed to burn ; if it be burned slowly, a strong dose will be borne without any sense of suffocation being produced ; the process must be repeated several times, for infection is very apt to hang about a room for a considerable time. In addition to its powerful disinfecting property, sulphur vapour seems to act favorably on the disease in some cases.

DURATION OF INFECTIOUSNESS.—There is very little reliable evidence as to the period of time during which a patient, who has suffered from diphtheria, should be regarded as infectious. And yet it is one of great practical importance, for change of air to the seaside is one of the best means for completing and assuring convalescence. Infection seems to cling to a room or to clothes more

tenaciously than to the patient, who, with proper precautions as to bathing, &c., is probably safe at the end of a week from the last local manifestation. But popular prejudices—if nothing else—would render it undesirable to think of moving a patient so early. I should say that one month at least ought to elapse from the last appearance of membrane before change is recommended, and before a child is allowed to mix with other children, and especially (on account of family proclivities) with its own brothers and sisters. Mr. VACHER¹ says, “I think that fourteen days are a safe maximum.”

DISINFECTION.—I will here just remark on the importance of disinfecting all discharges from diphtheritic patients as carefully as is done in cases of typhoid fever. In the former, the discharges from the mouth and air-passages are the most dangerous; they should be mixed with strong carbolic solution before being thrown away. The bed and body linen should be carefully disinfected, and washed separately from other linen. During the illness all drinking-cups and the like should be kept separate from those in use by the rest of the household. Toys which the child may have played with, sponges, &c., should be burnt.

¹ ‘Duration of Incubation and Infectiousness of Fevers’ (p. 14).

CHAPTER III.

LARYNGEAL DIPHTHERIA.

Identity of all membranous inflammations—Primary disease in larynx—The secondary form—Symptoms—Period to operate—Plea for early operation.

It is not my intention to enter upon the still disputed question of the identity or non-identity of 'croup' and 'diphtheria.' The subject was thoroughly discussed at the Royal Medical and Chirurgical Society during the early part of 1879, on the presentation of the report of a select committee, specially appointed to inquire into the "Relations between Membranous Croup and Diphtheria." I cannot do better than refer those who may wish for further information on this subject to this very excellent report, and to the debates to which it gave rise.

Suffice it to say, I agree with those who consider that these diseases are etiologically identical; the terms, therefore, as used in this book, 'membranous croup,' 'membranous laryngitis,' and 'laryngeal diphtheria,' are synonymous.

MODE OF ONSET.—Briefly stated, it may be said that laryngeal diphtheria is essentially a disease of childhood, and that it begins in one of two ways. It may attack the larynx primarily, or, beginning elsewhere, may spread to the larynx secondarily. In the former case the chief symptom is suffocation, outweighing and hiding all others.

In the latter, the laryngeal symptoms are preceded by those of depression and blood-poisoning. In both varieties the onset of the disease and its general and local intensity may vary within considerable limits, and in both alike will probably be modified by season and by surroundings as well as by the strength and age of the patient attacked. Diphtheria is peculiarly liable to attack an already inflamed surface. Thus, blistered surfaces frequently become covered with membrane; and it seems as if children who suffer from chronic pharyngitis or laryngitis are more exposed to the disease, *ceteris paribus*, than others not so affected.

1. DISEASE PRIMARILY AFFECTING THE LARYNX (*Syn. membranous croup*).—I cannot do better than quote from Dr. West's classical work (p. 422), "Croup generally comes on gradually, attended in *its first stage* by but few symptoms that could distinguish it from ordinary catarrh. Slight fever, drowsiness, suffusion of the eyes, and defluxion from the nares, attend it. The respiration is not perceptibly disturbed, and the cough, though frequent, presents no peculiar character. There is, besides, occasional complaint of slight sorethroat, or of uneasy sensation about the larynx, but so slight as scarcely to attract attention, and not sufficient to cause any alarm.

"The duration of this stage is very variable: nor is there any regularity in the mode of its transition into the *second stage*. In the majority of cases, indeed, the transition takes place gradually; but thirty-six hours seldom pass without the supervention of some symptom, which, to the well-schooled observer, would betray the nature of the coming danger. Most symptoms may continue unchanged, perhaps scarcely aggravated; but a slight modification takes place in the character of the cough, which now becomes attended with a peculiar ringing sound, difficult to

describe, but when once heard not easily forgotten. This peculiarity in the cough very often precedes any change in the respiration, and may sometimes be so slight as scarcely to attract the parent's notice at the time, and to be remembered only when the full development of the disease leads to inquiries as to how the attack came on. . . .

"Soon after this modification of the cough has become perceptible, or even simultaneously with it, the respiration undergoes a change no less remarkable. The act of inspiration becomes prolonged, and attended with a stridor as difficult to describe, but as characteristic of the disease, as the tone of the cough. It often happens that these two pathognomonic symptoms first come on, or at least first excite attention, in the night, and that a child who at bedtime was supposed to ail nothing, or at most to have a slight cold, awakes suddenly with ringing cough and stridulous breathing, frequently in a state of alarm with marked dyspnoea. Through the whole course of the disease, indeed, an obvious tendency exists to nocturnal exacerbations, and to remissions as the morning approaches. . . .

"Soon, however, the dyspnoea returns with increased intensity; the whole chest heaves with the inspiratory effort, which is more prolonged and attended with greater stridor. The cough does not increase in severity in proportion as the disease advances. . . . From the first appearance of the more marked symptoms the voice is hoarse, cracked; and whispering, or in young children is totally suppressed. . . . As the disease advances, the intermissions grow less distinct, and the child is constantly engaged with the effort to respire. . . ."

I will not quote the symptoms of the last stage of this

disease; for one object of this book is to advocate that surgical help be afforded long before matters come to this pass.

2. DISEASE AFFECTING THE LARYNX SECONDARILY (*Syn. Laryngeal Diphtheria, Diphtheritic Croup*).—This form of the disease is preceded and accompanied by diphtheria of neighbouring parts, as already described. "Sore-throat," as it is popularly expressed, difficulty in swallowing, and some little stiffness of the jaws will probably be among the earliest signs. On examining the pharynx its mucous membrane will be found swollen, œdematous, and glossy, and its surface spotted over with patches of membrane. The tonsils are generally swollen, and spotted also with membrane; the uvula likewise. The breath is foetid. Attempts to swallow cause pain and uneasiness. The glands at the angle of the jaw are usually swollen and tender. There is generally great constitutional disturbance; fever, a hot and dry skin, restlessness, and prostration. The voice at this stage will be pharyngeal in quality. These symptoms all vary greatly in intensity and duration.

The disease now spreads to the larynx. As a rule this spread is very gradual, and very insidious; and herein, it seems to me, is an explanation of one of the most palpable clinical differences between this variety and primary laryngeal disease described in the last section. In consequence partly of the antecedent blood-poisoning, but chiefly of the very gradual onset of the disease, the body becomes reconciled to its deprivation of oxygen; hence the suffocative symptoms (which are so prominent and so distressing in the other variety) are less marked, indeed, often absent in this. I have seen the disease far advanced before any surgical aid has been sought, the parents have been misled by the absence of the croupy

cough, and the struggling for breath, which are so often looked upon as the essential indications of 'croup.' Sometimes medical practitioners have themselves under-estimated the gravity of the disease on account of this apparent absence of discomfort in their patients.

In all other respects, the further symptoms would be identical with those which I have just quoted from Dr. WEST.

AT WHAT STAGE OF THE DISEASE SHOULD AN OPERATION BE ADVISED?—The amount of membrane deposited in any case as well as the submucous swelling vary very much, and the period, no less than the position, at which they occur, vary equally. For these reasons I have never been able to divide my cases rightly into stages as the French authors do. I am guided by the breathing in each individual case, rather than by any other indication. Thus it may be said that there is no stated period in the disease at which the operation must necessarily be undertaken. It is the effects, rather than the period, of the disease, which call for it; and the opportune moment must be decided on by the surgeon. I have already referred to recession of the soft parts of the chest wall, especially in conjunction with more or less complete suppression of voice, as a valuable test of the amount of obstruction. If expiration should be as laboured as inspiration, then there is no time to lose; for neither paralysis nor spasm will explain this. Mechanical obstruction is the only cause which can give rise to it.

At the discussion on croup and diphtheria already referred to, Dr. DICKINSON said, "If membrane be present and in the larynx, there is little hope but in tracheotomy, which, therefore, there is

no reason to delay." Seeing that the statistics of membranous laryngitis, taken collectively, show that the disease is fatal in about 90 per cent. of the total cases, I think Dr. DICKINSON's dictum will not lead us far astray. Bearing in mind the comparative harmlessness of the operation, as compared with the extremely fatal nature of the disease in question, as a surgeon I should prefer to be reproached with having occasionally undertaken an operation which was perhaps not absolutely necessary, rather than be obliged to look back on fatal cases which my own weakness and hesitancy had deprived of help, while there was yet time to render it.

In practising tracheotomy when children are about to expire, we run the risk, as TROUSSEAU said, "1st, of finding the false membranes occupying a very great extent; 2nd, of not being able to remedy congestion, engorgement, inflammation, and pulmonary emphysema, which are rather frequent occurrences in the last stage of asphyxia; 3rd, the operation also is rendered much more difficult, in consequence of the enormous swelling of the cervical vessels, the swelling being greater in proportion to the embarrassed respiration." Finally, let me add and emphasise GUER-SANT's advice, "the younger the child, the less can we afford to delay the operation."

APHORISMS.

The local condition in diphtheria precedes the general; the latter depends largely on the absorption of the septic products of the local condition.

The disease spreads locally by the contagion of its own products.

Spread of the disease must be combated by the complete destruction and removal of the products of the local lesion.

Death very generally occurs from extension of the disease into the lungs.

The value of any form of treatment may be gauged by the success with which extension of the disease is prevented.

The operation of tracheotomy is only indicated where there is evidence of mechanical obstruction in the larynx or trachea.

Retraction of the soft parts of the anterior chest wall during inspiration together with the

more or less complete suppression of voice, are the indications *par excellence* for the performance of tracheotomy.

Tracheotomy is in no sense a therapeutic measure; therefore, neither the local nor the general treatment of diphtheria should be suspended after the performance of the operation.

The chief objects of the operation are to facilitate treatment, and to guard against death from mechanical causes while this treatment is being carried out.

To be of service, the operation must be performed while the disease is local, and before its spread towards the lungs or general infection of the system places the patient beyond the reach of surgical help.

CHAPTER IV.

TRACHEOTOMY IN LARYNGEAL DIPHTHERIA.

Operation not a therapeutic measure—Treatment must not be suspended after operation—Anatomy of trachea—Details of operation—Chloroform—Tracheotomy tubes—Other instruments—Aspiration of trachea—Mishaps during operation—Treatment to adopt.

I WILL begin this chapter by particularly emphasising the fact that the operation of tracheotomy in cases of laryngeal diphtheria is not in any sense a therapeutic measure. Its performance, therefore, must not suspend the treatment which was previously being carried out, nor lead the surgeon to relax his efforts ever so little to check the disease. To quote Trousseau, the operation "consists in opening the trachea in order to give access to the air, the passage for which through the natural orifice of the glottis is nearly obliterated." (Op. cit., p. 415). Indeed, the making of raw surfaces by surgical operation in patients suffering from diphtheria is only justifiable when life is in danger, for such surfaces run considerable risk of being attacked by the disease. Trousseau, once an advocate of swabbing out the trachea with a little sponge fixed on a flexible whalebone handle, relinquished the practice as "appearing to have more inconveniences than real advantages" (p. 425); but he continued to teach to the last that all new "cutaneous manifestations ought to be followed à outrance by topical measures."

SURGICAL ANATOMY OF THE TRACHEA.—Although it is hardly probable that the various structures found in front of the trachea will be individually recognised during the performance of a tracheotomy, it may be as well just to bear in mind what these structures are.

FASCIE.—After the skin and superficial fascia we come to the deep cervical fascia, which in this part consists essentially of two layers—the superficial and the deep. The superficial layer is attached to the hyoid bone above, by blending with the fascia which attaches the two digastric muscles to this bone. It passes outwards towards the sterno-mastoid muscles, at the edges of which it splits so as to encase them. Below, it again divides into two layers which are attached to the anterior and posterior borders of the upper edge of the manubrium sterni, enclosing a little angular space, which contains cellular tissue, and sometimes also a gland. This layer covers the anterior surface of the sterno-hyoid and sterno-thyroid muscles. Beneath these muscles comes the deep layer of the cervical fascia, which is attached to the lower border of the hyoid bone. Passing downwards, it encloses the thyroid isthmus, and covering the front of the trachea, it extends into the thorax to join the anterior layer of the pericardium. Laterally it forms the sheath of the great vessels of the neck.

VEINS.—The next important structures are the anterior jugular veins, which are very irregular in their course and termination; they are placed immediately superficial to the sterno-hyoid and sterno-thyroid muscles, and are frequently connected by a transverse branch at the lower part of the neck. Normally there should be one on each side of the median line; not infrequently one is much larger than the other. Sometimes the left vein crosses over and terminates in the right one. A plexus of large veins surrounds the thyroid isthmus, opening above into the

superior thyroid, and below into the inferior thyroid veins. These latter are of considerable size, and one may lie immediately in front of the lower part of the trachea: they open into the innominate veins. It may be well to remind the operator that, in the child, the left innominate vein occasionally runs above the level of the sternum, and has more than once come into sight during a tracheotomy operation.

In all forms of pulmonary obstruction these veins become greatly distended. Apart from the troublesome hæmorrhage which follows if they are wounded, there is the further risk that air may be sucked in during the patient's struggle for breath.

ARTERIES.—The course and distribution of the cricothyroid, a branch of the superior thyroid, and of the thyroidea ima, an irregular branch either from the aortic arch or from the innominate, are of importance and must be kept in mind by the surgeon when operating.

In the child, the innominate artery is closer to the left carotid at the lower part of the neck than obtains in the adult. LÜCKE, when operating, once felt this artery beating close beneath his finger, immediately in front of the trachea. HÜTER made some anatomical researches on this point and found that the innominate not infrequently rises up perpendicularly along the trachea. There are also occasional abnormalities in the origin of the great vessels from the aorta, which may complicate the operation seriously.

MUSCLES.—The chief point to remark is, that the sterno-hyoid and sterno thyroid muscles are not quite in contact in the median line. At their upper attachment there is an interval of about an eighth of an inch, and as they descend they gradually get further apart. It is well to remember this fact, as it is a strong argument in favour of making an exactly median incision.

THYROID GLAND.—This gland consists of two lateral masses, united by the isthmus which lies across the trachea. The isthmus is chiefly concerned in the operation of tracheotomy. Its width varies considerably in different individuals, being generally larger in the female than in the male, a fact which explains in part why its position on the trachea appears to vary. In adults the isthmus usually lies over the second and third tracheal rings; but in children it is almost always higher up, generally on the crico-tracheal membrane and the first tracheal ring. I have not infrequently found it situate over the cricoid cartilage; in one case I dissected it covered the five upper tracheal rings. The various methods of dealing with it at the operation will be referred to elsewhere.

THYMUS GLAND.—This gland is sometimes largely developed and persistent in very young children, and in attempting the lower operation has not only been seen in the wound but has proved an obstacle to the carrying out of the operation.

TRACHEA.—The trachea is exceedingly moveable, and for very obvious reasons, thanks to the large amount of soft cellular tissue by which it is everywhere surrounded. From a surgical point of view this anatomical arrangement is not any advantage, for it permits of the trachea being easily displaced from the median line if the retractors or the sharp hook be unskilfully used during tracheotomy. Moreover, this soft cellular tissue quickly inflames and affords a dangerous resting-place in which pus and other exudation products are very liable to collect. In the chapter on 'Complications,' some reference will be made to this condition.

The trachea commences at the lower border of the cricoid cartilage on a level with the sixth vertebra and terminates opposite the fourth dorsal vertebra, by dividing

into the right and left bronchi; the surgical limit of the trachea, however, is at the upper border of the sternum. The distance from the cricoid cartilage to this spot is about four centimetres (TILLAUX) in a child four years old, and somewhat less in younger children. As the trachea passes down to the chest it recedes slightly from the surface of the neck, so that at the upper border of the sternum its depth is nearly one inch and a half. These points are well shown in fig. 1, p. 41, which represents a vertical section from before backwards. This direction of the trachea backwards as well as downwards is of great importance in relation to the spot at which the trachea should be opened, and to the shape of the tube, which should be inserted afterwards.

The size of the trachea is very variable even in individuals of the same age, and at different ages also. In twenty-four cases taken without selection from the *post-mortem* room, mostly young children, I found the average measurement to be $\cdot 374$ of an inch (9.350 mm.). The list included one medium-sized male, aged twenty years, with a measurement of $\cdot 550$ (13.50 mm.), which may be taken as a standard of comparison; one boy aged thirteen years, with $\cdot 475$ (11.66 mm.); and one girl aged eleven years, with $\cdot 425$ (10.43 mm.). The average of twenty cases of eight years and under, boys and girls, gave a measurement of $\cdot 356$ (8.74 mm.). These last include an infant aged nine months, with a measurement of $\cdot 250$ (6.14 mm.); an infant aged ten weeks, with a measurement of $\cdot 300$ (7.4 mm.); a boy aged two years and two months, with $\cdot 275$ (6.77 mm.); a girl aged three years and nine months, with $\cdot 500$ (12.27 mm.); and another girl with $\cdot 500$ of an inch (12.27 mm.). From the foregoing figures it will be seen how considerably the trachea varies in size.

Brief mention may be made of the great development

which the larynx and trachea commence to undergo at and after about twelve years of age ; this is out of proportion to that of the rest of the body ; it is more marked in boys than in girls, and has important bearings on the treatment of some of the complications which follow the operation of tracheotomy. After middle life the cartilages of the larynx and trachea show a tendency to ossification ; in advanced life this ossification is often so marked that a saw may be required to cut through them. The cricoid cartilage is the chief landmark. In thin subjects it can be readily made out, but in many young babies and in children with a large thyroid isthmus, or with much fat, it is not by any means easy to distinguish.

DETAILS OF THE OPERATION.

OUGHT CHLOROFORM TO BE USED ?—I have no hesitation in answering this question in the affirmative. After some considerable experience, I can truly assert that I have never seen any ill effects produced by its use. There is, not unnaturally, some little struggling when the inhalation is first commenced ; the child holds its breath, the face and lips become blue and congested, and the veins of the neck get full. But very similar results follow when the operation is done without chloroform, for the pain causes the child to struggle, and it also resents being held in a constrained position.

If the chloroform be slowly and carefully administered, a child may be "sent off to sleep" without any trouble or danger. For this purpose a few drops of chloroform should be sprinkled on a handkerchief or piece of lint ; it should then be held to the child's face by degrees. Two or three whiffs under these circumstances

suffice to make the child drowsy, after which the inhalation can be proceeded with more rapidly. It is the choking sensation of a large dose of chloroform, suddenly applied, which leads to struggling. At the commencement of the inhalation the child may be allowed to sit up ; the enforced recumbent position is generally resisted by children, as it is instinctively avoided by adults suffering from any form of dyspnoea.

Using these precautions I believe that chloroform may be safely administered to children with croup. Indeed, I have more than once seen the respiration become deeper and quieter after a few inhalations, and a state of repose brought on which eminently facilitates an operation, never an easy, often indeed an exceedingly difficult one.

VALUE OF AN ASSISTANT.—By way of preliminary, I would just say that, whenever it is possible, the surgeon will do well to have an assistant with him. It is true that one should be prepared to undertake the operation at any moment single-handed ; but this does not lessen the value of a good assistant, whenever it is possible to have one. Considering all the circumstances, there are few operations where skilled help is more welcome than in tracheotomy.

INSTRUMENTS.—It may be as well to say a few words about the instruments. Very few suffice. I think it is desirable to keep them apart in a small portable case, so that they are always ready ; for the surgeon is mostly summoned in a hurry, and if he have to collect his instruments, it is not improbable that some one or other may be left behind.

As essential, may be reckoned :

One small scalpel.

Two pairs of dissecting forceps.

One trachea dilator.

A selection of trachea tubes, and tape.

A trachea aspirator or an elastic catheter. Some feathers.

As useful, may be added :

Another scalpel. A fine saw. Scissors.

Artery forceps. One or two bulldog forceps.

Two double blunt hooks. One sharp hook.

Laryngeal brushes. The automatic retractor.

Needles. Ligature silk.

A reflecting mirror will also be found very useful.

Of chief importance among the foregoing instruments are the silver tubes ; a pocket knife might be very well used on an emergency, and retractors extemporised out of hair-pins ; but the tubes must be carefully made and cannot be readily dispensed with.

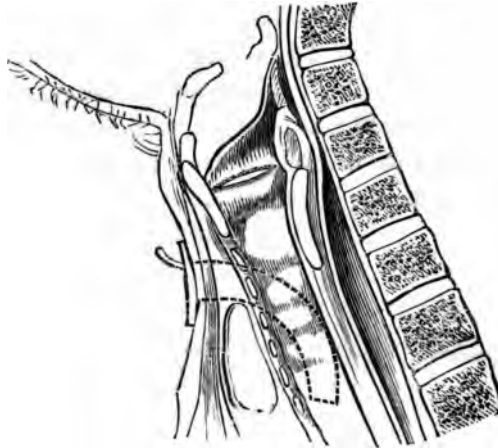


FIG 1.—Outline figure of the Trachea, showing its direction, and an Ordinary Tube *in situ*.

The curve of the tube is a matter of great importance. The ordinary quarter-circle tubes do not correspond with the natural direction of

Like Mr. Howse,¹ though for a different reason, I recommend the largest size tube that can be got into the trachea without violence and the shortest which is consistent with safety. BRETONNEAU's precept was that the tube "should have at least the normal diameter of the glottis of the subject." In gauging the size of a tube, always look at the inner one as being the smaller, and remember that the smallest diameter at any point determines its capacity for breathing purposes. Tapering tubes are therefore to be avoided; for while they necessitate a large opening into the trachea, they do not afford more ample breathing space.

While speaking of the tube, I must not forget to mention the value of a moveable collar. The invention is due to LÜER, the well-known instrument maker of Paris; it is undoubtedly one of the most important modifications which the tracheotomy tube has ever undergone, and was made at the suggestion of M. ROGER, who was one of the first to recognise the dangers of an ill-fitting tube.² Fig. 4 shows the mechanism of this movement, and Fig. 5 shows,

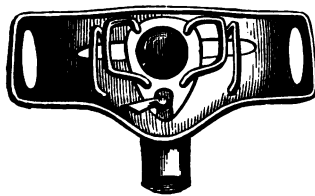


FIG. 4 shows the mechanism of the Moveable Collar.



FIG. 5 shows the advantages of a Moveable Collar.

by dotted lines, how the tracheal portion can alter its position during the various movements of the larynx and of the neck.

¹ 'Guy's Hospital Reports,' 1875, p. 495.

² 'Archives Générales,' 1859, vol. 2, p. 193.

It is of first importance that the tube should fit comfortably. The tapes with which it is held in place ought not to be tied too tightly round the neck, but they must be secure to prevent displacement by the child's movements. With the moveable collar it is hardly possible to cause pressure against the posterior wall of the trachea; formerly this was a not infrequent source of pain when swallowing food, and sometimes of vomiting also. It will be remembered that the posterior wall of the trachea is membranous and adherent to the œsophagus. Cases are on record in which it has been perforated by an ill-fitting tube.

For rigid tubes, silver is by far the best material; aluminium celluloid and vulcanite tubes, though rather less costly, have many drawbacks. I will just add that great care should be exercised in their manufacture; the extremity especially should be perfectly smooth, and its edges bevelled inwards. The inner tube should glide easily within the outer one, so that, when in use, the trouble of removing it for cleaning, and of replacing it afterwards, is reduced to a minimum; the lower extremity should project about the $\frac{1}{16}$ th of an inch beyond the outer tube, as in Fig. 2. The interior of the inner tube may advantageously be polished; for this facilitates the removal of all impurities.

Mr. MORRANT BAKER, in 1876, introduced a flexible tube: there can be little doubt that it will prove serviceable in many cases. Mr. BAKER believes that these tubes will materially lessen the danger of the intra-tracheal erosions, which sometimes follow on the use of rigid tubes. I have not a sufficient experience in their use to be able to speak authoritatively. But I feel sure that, unless they are appropriately shaped, erosions and granulations will occur.¹

¹ Dr. GOODHART showed a trachea with erosions on the anterior wall. The child had been tracheotomised for diphtheria, and had

Mr. WALSHAM has, I believe, suggested a form of pilot which facilitates their introduction into the trachea.

I will venture to describe one other instrument in this place—the tracheal dilator. All authors are agreed as to their importance, and it is not therefore strange that a great variety has been invented. The annexed drawing shows the instrument which I prefer to any other. It is

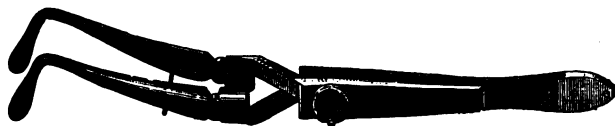


FIG. 6.—The Tracheal Dilator.

far preferable to the three-bladed instrument, which is recommended by some operators. The hinge in the blade permits of its being comfortably used in any position the patient may chance to be in, while the screw holds the blades open at any required width, and thus frees the operator's hand.

THE OPERATION.—The various instruments required should be laid out, and the operating table placed so as to secure the best possible light. The child is then placed upon it, and if this have not been previously done chloroform is now administered. When the narcosis is completed, the patient must be got into position. The point to secure is the greatest possible prominence for the neck. This is best accomplished by laying the child on its back, and putting beneath the shoulders a small round cushion (one may extemporise a very useful cushion by rolling an empty wine-bottle in a towel). It matters little how it is accomplished, provided the end be

worn a flexible tube for five or six weeks. ('Pathological Society's Transactions,' 1884.) Dr. CARRINGTON showed a similar condition
tto, ditto, 1885).

attained. I may just say that I have myself failed, and have seen others fail also, to get the neck into a suitable position from using too large a cushion.

The trachea may be opened either above or below the isthmus of the thyroid gland. These operations are respectively called the high and the low operation. In young children the high operation is generally selected, because it is very much the easier. It would perhaps be more rightly called a crico-tracheotomy, from the frequency with which the cricoid cartilage is incised, either accidentally or designedly. The low operation is more difficult, because of the greater relative depth of the trachea, the larger size and number of veins, and the vicinity of the great arterial trunks. The neck of a child is exceedingly short; it may almost be said not to have any neck at all. For these reasons the low operation should be discarded, unless some special reason exist to indicate it.

The child's head being well thrown back over the cushion, so as to make tense the tissues in front of the neck, and also to bring the laryngeal landmarks into greater prominence, and being held quite straight by an assistant, the operator, standing on the right of the table (Fig. 7), with his left fore-finger feels for the cricoid cartilage. A longitudinal, mesial incision is then made about one and a half or two inches long, in such a way that the cricoid corresponds to its mid-point. The incision should be a bold one, so as to include the deeper fasciæ as well as the skin. I believe this facilitates the operation; for probably at no other stage of the proceeding can one better than now appreciate and keep to the median line, where, as I have shown, there are really no important

structures to cut through, except perhaps the thyroid isthmus in exceptional cases. It will be seen, therefore, how advantageous it is to keep accurately to the median line of the neck, if one would not complicate the operation.

In exposing the trachea, I generally adopt von LANGENBECK'S dissecting method ; it does away with the need of



FIG. 7 represents the arrangement of the Operating Table, &c.

retractors. This method consists in using two pairs of dissecting forceps after the first incision has been made. One pair is held by the operator, who seizes hold of any tissue that needs dividing. His assistant, standing on the other side of the table (Fig. 7), with the second pair of forceps lays hold exactly opposite. The structure is then slightly drawn forward, raised from the wound, and

cut through. This is repeated until the trachea is bared. Any veins which present must be held aside. I must caution against making a funnel-shaped dissection: by this I mean, making the deeper incisions gradually shorter and shorter (as compared with the external one) until the wound assumes the shape of a funnel.

Unless in skilled hands, retractors are dangerous aids; for they are apt to displace the trachea itself from the median line, and thus lead to its being incised laterally rather than in the median line. If retractors are used, retraction must be made uniformly on the two sides. The double instrument figured below is the best for the purpose.



FIG. 8.—The Double Retractor.

They may also be used for keeping open the incised trachea in special cases where it is desirable to examine its interior or the larynx, when the usual dilator might be found a little in the way.

I will just allude to the 'automatic retractor' which I devised after having been once or twice suddenly called upon to perform tracheotomy, when there was no one near to assist me; and I need hardly say it is a very awkward

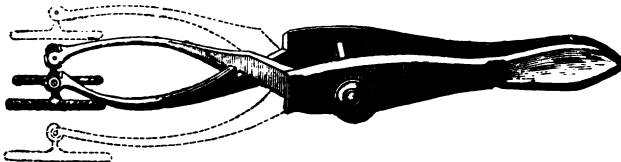


FIG. 9.—The Automatic Retractor.

operation to do alone. Under these circumstances, the 'automatic retractor' (Fig. 9) will be found useful. The

incisions into the soft parts having been made, the blades of the retractor are introduced closed (like an eye speculum), and after being opened to the required extent the screw is adjusted. It does not take the place of a good assistant, but may occasionally prove serviceable, when an assistant is not at hand.

The isthmus of the thyroid gland may be found in the way ; it may be got rid of either,—first, by simply depressing it with a blunt hook or retractor ; second, by deliberately cutting through it ; third, by Dr. BOSE's¹ method, which consists in making a transverse incision across the cricoid cartilage, so as to divide the layer of cervical fascia, by which the isthmus is bound down. A director is then passed in, and the thyroid gland, together with its vessels, are easily separated from the trachea without hæmorrhage, and may then be depressed. The first method, in my hands, has generally sufficed. As for the second, I have adopted it in a few cases without any harm or inconvenience. Of course, if the isthmus be unusually large or vascular, depression in one or other of the ways described may be previously tried. I have never tried BOSE's method on the living subject, simply because I have never had occasion to do so. The late Professor HÜTER considered the position and attachments of the isthmus a contra-indication to the high operation in young children. Certainly in cases where the isthmus is situated very high up it will be quite reasonable to raise up its lower border and incise the trachea below the isthmus if the surgeon thinks fit to do so ; for even then the trachea would be opened in its upper rings.

The cricoid cartilage and the two or three upper rings of the trachea having been exposed, the surgeon may now open the trachea. This should be done from below

¹ V. LANGENBECK, 'Archiv,' vol. xiv, p. 144.

upwards. Some surgeons at this stage recommend that a sharp hook be used to fix the trachea. With M. MILLARD I believe that this is an unphysiological proceeding, for the trachea cannot be fixed without arresting respiration. Moreover, I see no surgical advantage which is gained by so doing. The space, especially in a young child, is never very extensive, and it may be requisite to cut the cricoid cartilage in order to secure sufficient room for the tube. Indeed, I am inclined to believe that it is always advantageous to cut the cricoid. The crico-thyroid membrane may also be nicked without danger. For it is very important that the opening be ample, or otherwise the tube will not fit in comfortably. I hope it will not appear superfluous to emphasize the advantage of a straight incision into the trachea. Besides increasing the difficulty of inserting the tube, a zigzag incision is thought to heal less kindly than a straight one, and to be a source of delay in finally removing the tube. After the trachea has been incised, before the knife is withdrawn, a dilator is inserted, and the edges of the wound kept open. In common with Mr. HOLMES, Mr. MARSH, and other writers, I strongly recommend that the trachea be laid quite bare before it is incised. Much of the difficulty of introducing the cannula often depends on not observing this rule.

In a majority of cases, there will be more or less hæmorrhage. Unless very profuse, it may be disregarded. If arterial, the artery may be tied ; but if venous it almost invariably stops as soon as respiration is freely re-established. Occasionally the hæmorrhage proceeds from some vessel which has just been nicked ; in this case the vessel may be tied in two places and cut across. If, owing to some abnormal arrangement of the vessels, an unusual or dangerous amount of hæmorrhage should occur, it must be treated *secundum artem*.

It is very advantageous to examine with some care the interior of the larynx and trachea at this stage. By throwing up a light with a laryngeal mirror, it is usually quite easy to see the vocal cords ; the absence or presence of membrane can also be determined, and occasionally a doubt as to diagnosis may be cleared up in this manner.

Having arrived at this stage all immediate danger of suffocation will have passed. There will be no further need of chloroform, and the child may be allowed gradually to wake up. The trachea being now held open by the dilator, the surgeon proceeds to what is the most important part of the operation, viz. the clearing away of the exudation, which has been the cause of the laryngeal obstruction. This is accomplished very effectually by means of a feather. It must be previously soaked in a warm solution of carbonate of soda, then it is passed into the trachea, and gently but thoroughly twirled about so as to loosen, as well as entangle the membrane. This manœuvre gives rise to a little cough, by which the loosened membrane is expelled. Next, the feather must be passed upwards into the larynx, through the glottis, and into the mouth, where it will be seen frequently with shreds of membrane hanging to it.

It is very important that all membrane, as well as mucus, be thoroughly got rid of; for membrane is dangerous, not only because it offers a mechanical hindrance to respiration, but also because it is infectious to adjoining and contiguous structures. Another reason why the glottis should be carefully freed from all foreign matter is, that its presence here is a source of irritation, which distresses the patient. Under ordinary circumstances, we

can voluntarily clear the glottis of any irritating matter by coughing—a reflex process set up for the purpose. But after tracheotomy this is impossible, for the air is diverted through the tracheal wound. If it be found that the membrane is very tough or very adherent, or if it have already extended downwards below the point of the incision, it will be well to spray into the trachea some 20 gr. solution of carbonate of soda (*vide* page 67). This must be done for several minutes. It ought to give rise to some coughing; after an interval of a few minutes, the feather may again be used.

A still more effectual mode of dealing with retained secretions, membrane or otherwise, is aspiration by the mouth. As a rule, this aspiration may be undertaken without any fear; but in malignant cases and during epidemics, and also on account of special individual receptivity, the proceeding is not without danger to the operator. I have therefore devised a little apparatus—the ‘trachea aspirator’—represented in Fig. 10.

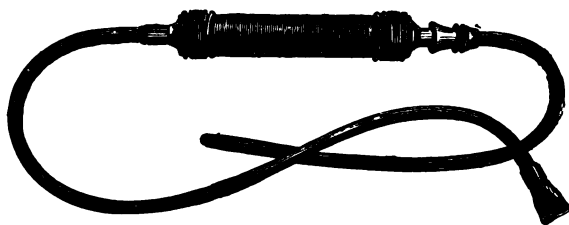


FIG. 10.—The Trachea Aspirator.

It consists of a small glass or celluloid cylinder, three or four inches long by three quarters of an inch broad; to one extremity of which a flexible hollow tube (a silk catheter) is fixed, and to the other a mouthpiece at one end of an india-rubber tube. The various parts unscrew to facilitate cleaning after use. When it is going to be

used the cylinder is loosely packed with some antiseptic wool, which effectually acts as a filter and prevents the *materies morbi* from entering the operator's mouth. It must be carefully cleansed after use each time. The advantage of using the mouth is obvious ; the operator can more readily and more delicately adjust the amount of force to be used ; he *feels* what he is doing, and is more expeditious and more certain in his results. In default of this, an ordinary silk elastic catheter, or even a piece of bent glass tubing, may be substituted ; the mouth-piece should be covered with two or three thicknesses of fine linen rag. If the tracheal wound is large, it must be closed in some way or other, in order to secure the vacuum necessary to make aspiration effectual.

The plan of putting the lips directly to the tracheal wound for the purpose of sucking out membrane is not to be recommended on any grounds, but chiefly because it cannot possibly be of any service to the patient, and may prove very disastrous to the operator. Moreover, it is based on a false conception of the source of the obstruction. Those who are most conversant with the appearances of the trachea will be the least likely to adopt the plan ; the obstruction requiring aspiration is rarely in the trachea (where membrane when present is generally very loosely attached), but at the bifurcation in one or other bronchus. The larynx and trachea having been well cleared out, the tube may now be inserted, and secured with tapes.

The introduction of the tube into the trachea is not always an easy matter. It may be that the trachea is not quite exposed, or that the incision is too small, or not quite in the median line, or that hæmorrhage obscures the opening. In all cases the surgeon must act delibe-

rately. If the opening, such as it is, is kept patent with the dilator no harm can come to the patient. Its exact size, shape, and position must be made out. If found too small (a very common fault) it must be carefully enlarged with the tip of the scalpel: if situated very much on one side, I believe it is better to make a fresh median opening and leave the other to close. I should especially warn against the use of the so-called bivalve tube under these circumstances. It can doubtless be very easily introduced even through a small opening; but this at best is a sorry way to overcome a difficulty dependent on an imperfect and insufficient incision into the trachea.

This chapter would hardly be complete without mention of some of the dangers which may occur during, as well as immediately after, the operation.

Apparent death.—From one of many causes or from a combination of circumstances—either because permission could not be obtained to operate earlier, or because the surgeon was not at hand, or in consequence of a sudden accession of dyspnoea, or in consequence of accidents and delay during the operation—the patient may cease to breathe and to all appearances may seem dead, before the operation can be completed. What should the surgeon do under these circumstances? I strongly advise that the trachea be opened and cleared out, and then that systematic, steady, and prolonged efforts by artificial respiration be made to restore the patient. I have several times seen cases apparently brought to life again, even after an interval of many minutes. It is important to bear in mind that our efforts are not likely to succeed, unless the trachea be patent as well as opened.

Blood in the trachea.—Occasionally, blood in considerable quantity may find its way into the trachea. It

may be in consequence of wounding some unusually placed vessel, or from having incised the trachea before it has been fully exposed. Sometimes, in very urgent cases, the surgeon loses a little of his calm, and makes his tracheal incision on one side, and after having withdrawn his scalpel he is unable to get in either the tube or the dilator. Thus, considerable quantities of blood may be drawn into the lungs, and by coagulating may add to the immediate danger and distress of the patient, while subsequently its decomposition may be the starting-point of a fatal septic pneumonia. In such cases, aspiration is clearly the remedy, and the little instrument figured on page 53 may advantageously be employed.

Surgical emphysema.—An untoward result, which sometimes occurs, is surgical emphysema. I have seen the entire neck, and even the face, swell up to double their usual size. It is usually ascribed to the escape of air through a non-median incision into a part of the trachea which is not thoroughly exposed. Now, although I have many times seen the trachea incised in more places than one, I have only once or twice seen emphysema. I am therefore inclined to think that the air must get into the cellular tissue in some other way. No explanation seems so reasonable as that offered by Dr. CHAMPNEYS, that it is sucked in by the inspiratory efforts of the patient; it is likely to occur therefore in cases where the dyspnoea is most urgent, or in unduly prolonged operations during which the patient is generally held in a very constrained position. The remedy is obvious. I believe it is well to disregard all previous incisions, and to make a fresh one in the median line, quite irrespective of them; for as soon as a free opening is once established, no further ill consequences happen and the smaller openings close spontaneously.

The operation fails to relieve.—It sometimes happens, even after a well-performed operation, and, notwithstanding a careful incision of the trachea, that the insertion of the tube is not followed by that relief which we always so anxiously look for. The secret is often to be found in the fact that the trachea has not been sufficiently cleared out, or that the tube has actually been inserted between the tracheal wall and a complete membranous cast which it has but partially thrust aside. Indeed, I have an anatomical specimen illustrating how this may occur. The surgeon often feels that his patient is not safe until the tube is inserted, and he hurries to accomplish this. But let it be remembered that, with a dilator in use, immediate danger need not be apprehended; while on the other hand, a tube inserted too soon may prove but a false security.

Occlusion of a bronchus.—I must also just refer to the possibility of one or other bronchus being more or less occluded by shreds of membrane loosened by the feather or by clots of coagulated blood which may have been drawn in during the operation. Such a condition may be suspected when air does not enter the chest freely, and where the physical signs do not point to consolidation or disease of the lung itself, or in cases where one side of the chest fills more perfectly than the other. In such cases, the tracheal aspirator should be introduced, and an attempt made to remove the obstruction.

As regards this apparently rough handling of the interior of the trachea, I will express my own conviction, based on many years' experience, that it may be undertaken and carried out freely, without any hesitation. I believe this treatment is infinitely less irritating and less dangerous to the trachea than the sojourn of membranous

exudation upon it. I have never had occasion to regret carrying this treatment out too freely, but I have occasionally blamed myself—when too late—for not having sufficiently acted up to my precepts. Moreover the presence of membrane in the larynx or trachea after death, in a case of laryngitis for which tracheotomy has been performed, is a condition which few surgeons, I think, will care to contemplate; since the main object of the operation has been to remove this membrane.

CHAPTER V.

DETAILS OF AFTER-TREATMENT.

*The sick room—Nursing—Indications for after-treatment—
Steam—Croup bed—Croup kettle—Disinfectants—
Sedatives—Solvents—Suction of Trachea—Manage-
ment of tube—Diet.*

THE SICK ROOM.—The room for a patient after tracheotomy should be as far removed from the rest of the household as possible; it should be large and airy and by choice have a south aspect. All unnecessary furniture should be removed as well as the carpet and curtains. A fireplace is almost essential. The doorway should be guarded by a large sheet, kept constantly wetted with carbolic solution. The room should be near a w.c. in order that discharges of all kinds after being carefully disinfected may be easily got rid of, without having to be carried through the house.

NURSING.—A well-trained nurse to take charge of the patient is most essential. Although a few cases recover without having a nurse, yet a large number die, chiefly in consequence of insufficient nursing. Neither good intentions nor devotion suffice. The nurse in charge of a tracheotomy needs the special knowledge which special experience alone can give. For she has to deal with an insidious disease, affecting the most vital function of the body. An unrecognised plug of membrane in the tube may suffocate the patient in a few seconds, before other

help can be summoned, although the danger could be removed with a feather. The tube may get displaced by accident; even if she could not replace it a trained nurse would know how to use the dilator until the surgeon could be sent for, and thus save her patient.

But there are many other duties, hardly less important, which can only be trusted to a good nurse. Cleaning the tube, the regulation of the steam apparatus, the administration of medicines, and last, but not least, the administration of nourishment. On all these points the nurse must be full of resources, apt, and ready to do the right thing at the right moment. She must anticipate her patient's wishes, and instinctively feel the little troubles and sufferings which he can no longer give utterance to. Above all, her supervision must be constant and untiring; in the absence of the surgeon, she must have complete control over the patient.¹

CHIEF INDICATION AS TO AFTER-TREATMENT.—As the chief object of the operation has been the removal of a mechanical hindrance to the admission of air into the lungs, so the chief indication in the after-treatment is the prevention of any subsequent recurrence of this obstruction.

It is almost needless to say that the false membranes in these cases have a marked tendency to re-form, often more than once, after removal; and hence it behoves the surgeon to be constantly on the look-out for the earliest symptoms which betoken such recurrence. Among the most suggestive must be reckoned a want of tracheal secretion from the wound—a 'dry tracheotomy'—as the phrase goes in the wards. Immediately after the opera-

¹ The surgeon must not forget that a nurse requires rest and fresh air, especially while in charge of diphtheria patients. A stated amount of sleep, and of exercise in the open air, are as essential to her health as health is essential to the proper discharge of her duties.

tion, after all membrane has been feathered away, there will generally be some secretion ; and if in the course of a few hours this secretion ceases and if the breathing through the tube is dry and whistling, a fresh deposit of membrane may be suspected ; the trachea ought to be carefully examined, and whether membrane be seen or not, it will be advantageous to feather it out again with a little glycerine of boracic acid. This proceeding may be repeated several times, at short intervals if necessary. I have already expressed my opinion that membrane is dangerous, not only because it mechanically interferes with the admission of air into the lungs, but also because it is infective. Its continued formation is, moreover, the visible proof of an active infective process still going on ; and there is an ever-increasing danger of what at first is a purely local disease passing into the lungs and becoming a general disease. I again refer to this point because it ought ever to be present to the surgeon's mind, and should constantly influence his plan of treatment.

VALUE OF STEAM.—Various means may be used to facilitate the removal of membrane. I have already referred to the use of a feather at the time of the operation and subsequently. Perhaps the most important aid, however, is the inhalation of steam. For this purpose the patient's bed should be surrounded with curtains. The plan I found in use at the Hospital for Sick Children many years ago, when Resident Medical Officer, seems to me the most suitable. A rod (of wood or iron) is strapped to each one of the four legs of an ordinary cot ; these four uprights are then connected together by four cross rods, as in Fig. 11. In this manner the cot is converted into a four-post bed. Ordinary white sheets are then thrown over this extemporised framework, so as to cover-in the cot on all sides but one. The advantages of

this kind of bed, whether it is used in private houses or in hospital wards, are obvious. In the first place, it isolates the patient, and gives us greater control over his surroundings than we could otherwise have. Next, it does not exclude the light, and we can regulate the temperature of the air, and the amount of steam; and further, we can make the steam the vehicle for various kinds of medication—antiseptics, anodynes, stimulants, or expectorants, according to the requirements of the case—and this, too, without in any way interfering with the comfort of the other occupants of the room or the ward, as the case may be.

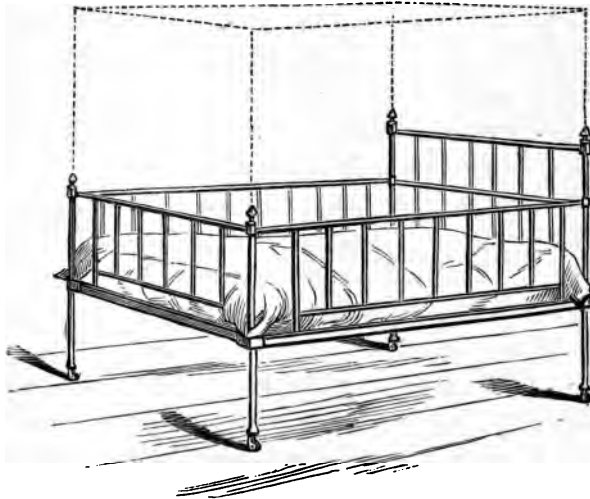


FIG. 11.—An ordinary Cot. The dotted lines represent the moveable iron framework.

A small steam apparatus is kept boiling on a table close by, from which a certain amount of steam must be conducted into the bed, as in Fig. 12. The framework can be extemporized out of wooden laths, or in any other way; but for the sake of convenience, I have

designed a light, portable, expanding iron frame, which will adapt itself to any bed, and which the surgeon can carry with him, as part of his croup *armamentarium*.¹

Even if the case is in a separate room, it is a great advantage to have such a means of isolating the patient; for, thanks to the protection of the curtains and the warmth supplied by the steam apparatus, the door and

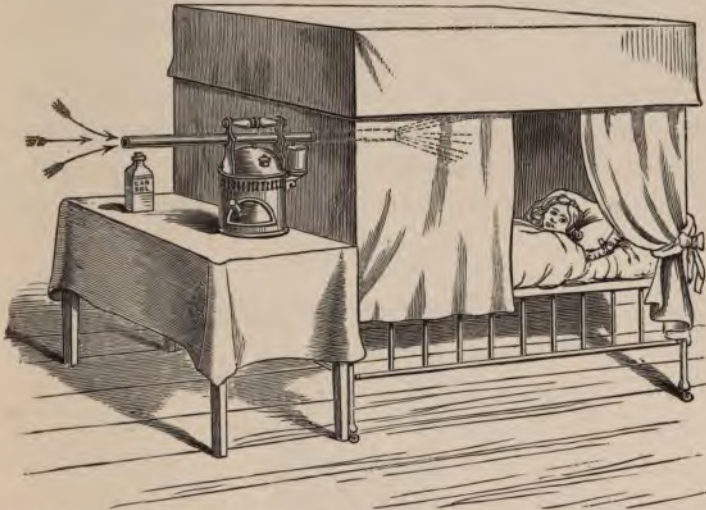


FIG. 12.—The Croup Bed complete, with the steam apparatus. The arrows indicate the current of air which is being insensibly introduced along with the steam.

window of the room can be opened without any fear of draughts, and a free ventilation kept up. This is of importance both to the patient and the nurse. If the case is in a hospital ward, in which there are other patients, the ward can be ventilated as usual; and if it happen to be a children's ward, the danger of infection (except in very

¹ It can be obtained of Messrs. ALLEN, Marylebone Lane, London, the manufacturers of the croup kettle and of a convenient steam spray.

malignant cases or during epidemics) is in this manner practically abolished.

The plan (in use at some hospitals) of drawing the bed close up to the fireplace, surrounding it with the ordinary ward screens, and then covering them in with blankets, does not seem to me as good as the one I have just recommended. For it is more difficult to regulate the temperature, and it frequently deprives the patient both of the fresh air and light, which are so necessary for his recovery.

In order, however, to secure the full benefit of steam, and especially when using the "croup bed" just described, it must be applied scientifically. For this purpose, the Ventilating croup kettle is the most useful. It was



FIG. 13.—The Ventilating Croup Kettle.

made, at my suggestion, on the principle of the ingenious 'steam draught inhaler' invented (at the suggestion of the late Mr. NAPIER) by Dr. LEE, differing from it chiefly in size, and one or two other points, which, while they render it more suitable for this purpose, lessen its value as an inhaler.

The mechanism of this kettle is shown in : it is

essential to understand the principle on which it works, or otherwise accidents may occur. A A is the combined air and steam tube, B represents a smaller tube, through which steam, at high pressure, issues from the boiler into the tube A A. Owing to the velocity with which the steam issues, the air in the tube is driven out at one extremity, while fresh air rushes in at the other to replace it. In the course of a short time the tube A A becomes heated, and the air in passing through it also becomes heated. A constant current of fresh, warmed, moist air is thus supplied.

The following general instructions as regards the kettle will be found useful. See that the steam nozzle is patent, or otherwise an accident may occur. The boiler should never be more than three quarters filled. Boiling water should be used for the purpose. The amount of flame should vary with the amount of steam required. If any medicaments (all of which must be volatisable) are used, they must be mixed with a little warm water in a measure, and then poured into the kettle with the hot water. Always remove the lamp and let the steam go down before opening the boiler. Be careful that the kettle does not boil dry. If any resinous substances have been used (such as benzoin), let the kettle be carefully washed with strong soda and water before it is put away; the steam nozzle also should be screwed off and carefully cleaned. When not in use, the kettle should be kept empty and dry.

The amount of steam required varies with the individual case. Its indication may, I think, be formulated thus:—The less there is of tracheal secretion, the more is steam needed; and the converse. An error is in all cases to be avoided, the patient. Steam acts on the
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The amount of steam required varies with the individual case. Its indication may, I think, be formulated thus:—The less there is of tracheal secretion, the more is steam needed; and the converse. An excess, however, is in all cases to be avoided, as it tends to depress the patient. Steam acts on the bronchial mucous membrane much as it acts on the skin;

it encourages secretion ; the secretion tends to loosen the membranous exudation, and so bring it within the current of the expired air, by which it is expelled. It may be made the vehicle of important medication, of which not the least important is disinfection.

DISINFECTANTS.—The importance of systematically using disinfectants cannot be over-estimated. There is abundant evidence to show that diphtheria not infrequently arises from exposure to drain emanations. This, I think, is not to be wondered at, if the exudations of patients suffering from diphtheria are thrown away without being thoroughly disinfected, just as is now done with the stools of typhoid patients. So, too, with the air they breathe. By adding a little carbolic acid or creasote to the water in the croup kettle, a disinfecting atmosphere can be supplied to them, which will tend very much to lessen the chances of a spread of the disease.

Creasote, besides being disinfectant, has a stimulating influence on the bronchial mucous membrane, and promotes secretion. The oleum pini sylvestris belongs to the same class, and is an aromatic expectorant possessing antiseptic properties. Many other substances may be used ; such only, however, as are volatile should be tried. Eucalyptus oil and thymöl are both agreeable and useful. Small quantities of sulphur may advantageously be burned from time to time.

SEDATIVES.—Under certain circumstances, it may be well, while keeping up a gentle disinfecting vapour, to apply from time to time sedatives. There is often a troublesome cough, which distresses the patient. In such cases, Dr. LEE's Inhaler will be found of great service, for more highly medicated steam can be applied directly to the trachea than is possible with the croup kettle. Thus the compound tincture of benzoin (3j ad 3j) when

inhaled is an excellent sedative. It may be combined with a few drops of chloroform, or given alone, according to the requirements. When an inhaler is not within reach, a good substitute is a large soft sponge wrung out of boiling water on to which the benzoin or other medicament is dropped. The sponge is then held in front of the tube for a few minutes at a time.

THE VALUE OF SOLVENTS.—Next in importance to steam come solvents,—drugs the action of which is to liquefy mucous and membranous exudations.¹ Soda and potash are the most valuable of this class.

On the whole, and after many experimental trials, I am inclined to regard the soda solution as the most generally useful. (Sodæ Carbon. ʒiiss—ʒiiss, Glycerini ʒij, Aq. Destill. ad ʒviij). It may be sprayed in front of the cannula, in such a way that the spray is inhaled; this may be continued for five or ten minutes at a time, and repeated at longer or shorter intervals through the day as circumstances dictate. Fig. 14 shows a convenient arrangement for spraying a child.

The child is seated on the nurse's knee, and is then covered with a waterproof in order to protect its dress from wet and damp. A steam spray should be used if

¹ The following experiment can be tried:—Place portions of well-formed membrane in different test tubes, severally containing a solution of saccharated lime, of carbonate of soda, of carbonate of potash, and of distilled water; very marked differences in result will be obtained. The lime solution will quickly dissolve the membrane; the soda and potash solutions also, but they will require a somewhat longer time; the distilled water will not produce any effect for several days, and then only by leading to decomposition. In any given case, where it is wished to liquefy and disorganize the membranous exudations, one or other of the solutions may be used. The lime, though more active in the test tube, is so quickly altered by the carbonic acid in the expired air that it becomes inert in the trachea.

possible ; for the fluid to be sprayed is thus more minutely divided, and it penetrates more easily into the air-passages. Otherwise a hand spray may be used.

After each spraying let the feather be introduced so as to detach and get rid of any shreds of loosened membrane.



FIG. 14.—Mode of using the Spray.

The soda solution is useful, I believe, not only because it liquefies any membrane with which it comes in contact, but also because it renders the exudation material less organisable.

SUCTION.—There is another means by which false membranes, inspissated mucus, blood, &c., may be got up from the trachea and primary bronchi, should neither steam, nor the use of feathers, nor the solvents suffice. It may be sucked out. I have already referred to this method in describing the operation (p. 53), but think it well to again mention it under the 'after-treatment,'

where it is generally most required. Obstructed breathing may frequently be relieved by this means, and success obtained where, without it, death would be inevitable.

Suction should never be made directly from the tracheal tube or from the wound; it can only be of service in cases where there is mechanical obstruction, and in order to obtain its fullest advantages the instruments used should be in direct contact with the material to be got rid of. Thus it is important to use the feather and endeavour to detach the membrane, but should this not succeed, or should membrane or inspissated mucus get wedged in the bronchus, then suction carefully applied may prove of great benefit. If the trachea aspirator is used, the tube should be directed towards that bronchus which appears obstructed, and after closing the wound with the finger and thumb over the tube, gentle suction with the mouth should be made. As a precaution the mouth may be washed out with carbolic solution afterwards.

From within a short time of the operation, there will probably have been some secretion from the tracheal wound, and if there is much cough the mucus, together with the air, will give rise to a 'rattling' sound which at first causes anxiety to the attendant. This, however, is not an unfavorable sign. Whenever much mucus is being expectorated it should be cleaned off the tube with a sponge, and the tube itself must now and then be cleaned out with a feather. Be careful, however, not to worry the patient with too much attention.

Speaking generally, I would say that a free secretion from the trachea is not an unfavorable sign. Indeed, it will be seen that one object of the treatment

just proposed has been to encourage secretion in the first place, and to secure its removal in the second. On the other hand, a dry tracheotomy is generally to be regarded with anxiety. The dry cases are usually exceedingly tolerant of interference, allowing a feather to be inserted into the trachea without any reflex cough. This, too, is a very unfavorable sign, and should always induce a most guarded prognosis. Our efforts to promote secretion should be redoubled, the child's general condition carefully examined, and any special indication met by a corresponding effort to overcome it.

CHANGING AND CLEANING THE TUBE.—We next come to consider the question of changing and cleaning the tracheal tube. How often does it require cleaning? is the first point one naturally thinks of. The inner tube must be taken out every hour or two, and cleaned with a feather and warm water. If the mucus is very tenacious, the soda solution will be found useful, and may be used instead of plain water. If the patient's temperature is very high, the tube will require more frequent cleaning; for the metal tube gets heated by the body, and the secretions are more apt to inspissate in consequence. The exterior tube also ought to be cleaned after the lapse of twenty-four to thirty-six hours. This is a useful proceeding for many reasons; it allows us to detect the earliest signs of unhealthiness in the external wound, as well as to apply the appropriate remedies. Sometimes the tube after its removal from the trachea will be seen to be blackened. If such is the case let the wound be carefully examined. Each of the black patches (due to the sulphuretted hydrogen of decomposing discharges) will be found to correspond with some unhealthy or sloughing spot in the trachea, which must be treated accordingly. Indeed, I regard this blackening of the silver tube as an important

aid in diagnosis ; it is often the earliest manifestation of a morbid process, which if not checked at once may prove of great danger to the patient. There is not much difficulty, as a rule, in re-introducing the tube ; but it is always well to have a dilator at hand, in case difficulties should present themselves. I generally keep a second tube ready, identical in all respects except length, with which to replace the one removed ; and so alternate from day to day as circumstances suggest. This is an effectual method of preventing the erosions of the tracheal wall, to which reference will be made under 'Complications.' Another advantage of taking out the exterior tube is that it affords an opportunity for testing the breathing power through the larynx.

The re-introduction of the tube, as I have just said, is not as a rule difficult, for the incised tissues in front of the trachea all become glued together with inflammatory lymph ; and a tunnel leading directly into the trachea is quickly formed. It is in itself a good sign, when this adhesion takes place, for while it facilitates access to the trachea, it prevents bagging of secretions among the intermuscular planes, to which reference will again be made under the heading of 'Complications.' In some cases, however, no such adhesion takes place, or it takes place but slowly, and then the re-introduction of the tube is proportionately more difficult. In these cases it will be necessary to have the dilator at hand, and proceed as deliberately and much in the same way as at the operation. I do not think that this asthenic condition of the wound should interfere with the proper changing of the tube ; indeed, its condition can never be rightly gauged until the first dressing has been carried out ; and with the possibility of finding the way into the trachea not yet well defined, it is always wise to do this first changing of

the tube with the child on the operating table, and one's instruments all ready to hand. In a few cases, the edges of the wound may be found in a very unhealthy condition, or deposits of membrane may be seen; we must treat them on general principles, not forgetting what has been said on the importance of destroying all local manifestations, whenever and wherever met with.

PERMANENT REMOVAL OF TUBE.—Finally, we have to consider the permanent removal of the tube. If it is regularly taken out, as recommended, for cleaning purposes we shall be able to test the condition of the glottis from time to time; and it is well to do so, and to commence our trials about the third day. It will be evident that we cannot make satisfactory trials so long as the tube is in the trachea, even although the tube may have a window in its posterior wall. Some surgeons simply place the finger tip over the orifice of the tube. I much prefer to remove it, and then completely close the opening into the trachea with a pad of wetted lint, lightly tied round the neck with a soft bandage.

The first few breaths are often very laboured. As a rule, it is chiefly during inspiration that difficulty is experienced; but occasionally expiration is also difficult. The surgeon must persevere as long it is safe to do so and renew his attempts at short intervals. A very easy way of testing the patency of the larynx is to allow the patient to fill his chest through the tracheal wound, and then to force him, if possible, to expire it through the larynx. If this can be accomplished it will be an indication that there is no mechanical impediment in the larynx; if it cannot it will be an indication to ascertain its nature and if possible remove its cause. It is a good plan also, even before the tubes can be finally removed, to make the child attempt to phonate; for this exercises the muscles, and

overcomes the rigidity arising from inflammatory thickening. It will be found useful to spray the pharynx with strong alum solution, especially when the child is trying to use the larynx, for the spray will be drawn in along with the air, and so reach the glottis. Usually there are no great difficulties; such as there are will be considered under 'Complications.' The tube having been removed the wound may be allowed to close. A pad of wet boracic lint, fastened over the wound with a turn of bandage is usually all that is required. If granulations spring up, they may be lightly touched with nitrate of silver stick.

Dr. SANNÉ, in his excellent thesis, states that from the fifth to the ninth day after operation is the period during which the tube can most frequently be removed permanently; in my own experience the average time lies somewhere between the eighth and eleventh days.

DIET.—The late Professor TROUSSEAU used to teach that a good appetite was one of the most hopeful signs in a child that had been tracheotomized. Unfortunately it is rather uncommon, and not a little after-trouble consists in persuading our patients to take nourishment. On this account, we must be on our guard against overdoing it. I have known otherwise excellent nurses ply their patients every half hour or oftener, for days together, with either milk or beef tea, or some other article of diet, that may have been ordered. This practice I consider as injudicious as it is injurious. It is impossible for the stomach to be digesting food continuously; and unless the food is digested it only distends the stomach and gives rise to general malaise and discomfort. In children or even adults, where the depression is great, this digestive inactivity specially obtains; hence at *post-mortem* examinations it is very common to find the stomach so much distended with undigested food that the

heart's action, as well as expansion of the lung, must have been materially interfered with. In other cases, this ill-advised feeding leads to vomiting, and to a not unnatural repugnance to food.

It is, I know, easier to advise what ought not to be done than to give any definite instructions as to what should be done. The moral of what precedes is that a little food which is digested is of greater value than a large quantity which is merely swallowed.

By some it is considered necessary to order beef tea and milk quite irrespective of the likes or dislikes of the patient. Children, as a rule, dislike beef tea. Under these circumstances I should not advise its being pressed. The same as regards milk. More solid food may be given, if it be wished for, without any danger. Indeed, soft solids are often more easily swallowed than liquids. The latter seem to find their way into the larynx, and then they give rise to coughing. Beef tea or milk may now and again be advantageously thickened with biscuit powder, sago, tapioca, the yolk of an egg, or with chocolate; the addition of a little cream is also useful. Beef tea may also be given cold in the form of jelly; it should be variously flavoured in order not to pall on the appetite; and great care must be exercised in making it really palatable. Light puddings are sometimes relished, served with a little fruit juice. Raw, or undercooked lean meat, chopped very fine, or pounded, is another excellent way of administering food. A little home-made calves'-foot or chicken jelly is an excellent and nourishing food. They may be given in a semi-liquid form. At all stages of the disease fresh fruit or the juice, if it can be had, will be found useful: apart from its febrifuge qualities, fruit is refreshing and appetising. Roast apples or pears, freed from skin and husks, may be

given in moderation. A little orange, or lemon covered with fine sugar, may be sucked from time to time.

If other measures fail, forced feeding, as recommended by TROUSSEAU (op. cit., page 424) must be resorted to. A soft silk, or india-rubber, catheter (No. 7 size) is better than the ordinary rigid œsophageal tube. This must be passed through the nose into the stomach; to the free extremity either the nozzle of a glass syringe, or the stem of a glass funnel is fitted, and a measured quantity of suitable food is poured in. Mr. BATTAMS, Resident Medical Officer at the East London Children's Hospital, who has had considerable experience, has devised a very useful and simple syringe-feeder for this purpose, which is described in the 'Lancet' of June 16th and 23rd, 1883. Children become reconciled to this mode of feeding very quickly, when it is carried out gently.

A little good wine, brandy, or brandy mixture (B.P.) will sometimes sustain life, and put the patient over a period of depression and exhaustion, which would be fatal without it. This is especially the case where from any cause the vomiting is severe, and accompanied with diarrhœa. Nutritive enemata, thickened with raw starch and containing a small opiate, may be administered every few hours. Vomiting and diarrhœa in a few cases occur and persist; they are very exhausting. I believe they sometimes depend on the action of drugs given before the operation. Their action of course tends gradually to wear off.

I will close this chapter with another caution against too frequent feeding. Every two hours is often enough when the food has to be forced; and then a measured quantity should be given. If the patient ask for it oftener, well and good. The return of the appetite is a most hopeful sign, and generally a harbinger of success.

CHAPTER VI.

COMPLICATIONS. ILLUSTRATIVE CASES.

Complications divided into immediate and remote—Cases illustrating these conditions, with remarks—Difficulties in removing the tube—Mental agitation—Miscellaneous cases—Sudden deaths—Undetected foreign bodies.

THE term 'complications' is here used in a rather wide sense, and may be defined as any conditions which retard or prevent the restitution of the laryngeal function and the permanent removal of the cannula. I shall refer only to such complications as are concerned directly with the operation. Septic (broncho-) pneumonia will not therefore be included. I cannot agree with those who attribute the pneumonia to the tracheotomy, as it seldom ensues on this operation when undertaken for conditions other than diphtheria; whereas it (pneumonia) is constantly found *post mortem* in cases of diphtheria which have not been tracheotomised.

Contrary to the view expressed in the first edition of this work, as the outcome of greater experience I now hold that the operation of tracheotomy in diphtheria does introduce an additional (though small) element of danger. The freshly incised tissues with their innumerable arterioles and venules and lymphatics are so many additional channels into which the virus may directly penetrate; and that it does penetrate is clearly shown by the frequency

of inflammatory complications, such as are rarely if ever seen when the operation is done for the removal of a foreign body or for chronic disease. Some of the cases I am about to relate do not strictly belong to a work on laryngeal diphtheria; but in all cases of obstruction in young children it is desirable to eliminate diphtheria as a possible complication, even although the obstruction may be said to be of a chronic nature. As is well known, diphtheria shows a great tendency to engraft itself on an already unhealthy, congested mucous membrane. The cases will serve to show the variety of conditions which may lead to laryngeal obstruction in young persons, and suggest points of differential diagnosis as well as the line of treatment to be pursued in similar cases.

The complications most frequently met with may be arranged in two chief classes:—The Immediate, and the Remote.

1. IMMEDIATE.—These are more or less of an acute character; they come on within a few days or hours of the operation, and may not inappropriately be described as wound complications.

- (a) Diphtheria of the wound.
- (b) Inflammatory œdema of the neck.
- (c) Erysipelas.
- (d) Surgical emphysema.
- (e) Absence of reparative power.

2. REMOTE.—Generally very chronic.

- (a) Acute or subacute changes in the pharyngo-laryngeal mucous membrane, due to the lesion for which tracheotomy has been performed. (Scalds, corrosive fluids, syphilis, necrosis of laryngeal cartilages, undetected foreign bodies, ulceration and granulations in trachea, &c.)

- (b) Chronic catarrhal changes (including papilloma).
- (c) Irritative changes due to the presence of a tube.
- (d) Ulceration of trachea due to an ill-fitting tube.
- (e) Accidental conditions.

Difficulties in permanently removing the tube, with remarks and cases: Miscellaneous cases. Sudden death. Undetected foreign bodies.

1. THE IMMEDIATE COMPLICATIONS.

(a) Diphtheria of the wound.—The frequency of this complication does not seem to depend (as I formerly thought) either on the severity of the primary disease, or on unfavorable hygienic influences to which the patient may be exposed after operation. I am quite unable to offer any satisfactory explanation. In my own practice it has only occurred twice; on each occasion it was slight but well marked. In one case, on removing the tube two days after the operation, I found the edges of the wound patched over with little islands of false membrane; in the other case a similar condition was found; the edges of the wound became everted, with a margin of erythema around them. In both cases I applied the hydrochloric acid and glycerine, and they recovered without further trouble. The membrane in these cases was white and characteristic; it occurred in little patches. It is quite a distinct condition from the sodden unhealthy wound, the surface of which becomes ash-grey in colour, and secretes a thin, foetid, ichorous pus such as is not infrequently seen in severe cases of general diphtheritic infection and to which I shall presently allude.

Almost all French authors refer to this complication. TROUSSEAU (op. cit., p. 423) taught that "during the first

four days the entire surface of the incision should be vigorously cauterised once a day; one may thus avoid a very redoubtable complication—the diphtheritic infection of the wound.” MILLARD also, in his excellent thesis, to the teachings of which I take this opportunity of expressing all my indebtedness, somewhat later, under the heading of ‘Local Treatment’ (p. 74) stated as a ‘fundamental rule’ that “whatever be the condition of the wound it ought to be cauterised during the first three or four days.” Such treatment is no doubt necessary under the hospital conditions in which it was advocated by these experienced physicians.

It is highly probable, however, that the term diphtheria has often been used to describe conditions which in England would be called sloughing or hospital gangrene. Indeed SANNÉ, a distinguished ‘*Interne*’ of the Children’s Hospital in Paris, admits as much in his thesis on Tracheotomy. He gives (p. 80) ‘under all reserve’ a table of the cases of diphtheria of the wound observed between 1855 and 1868 inclusive; in 252 cases of tracheotomy this complication is reported to have occurred in seventy-two cases. In two of the years there were no cases; and in one of the years as many as twenty-two.

This author, very properly I think, draws a distinction between diphtheria and a sloughy condition of the wound. In the latter case, the surface assumes an ashen-grey colour and secretes a thin offensive pus; but nothing like a membrane can be peeled off. Recovery can only take place after this gangrenous tissue has separated. Such a condition as this I consider directly due to ‘Hospitalism,’ and I believe it is much more common in the French hospitals than in our own, because less care in isolating infectious cases is exercised in Paris than with us. I make a difference between this condition, which is

highly infectious, and may be a purely local one, and the following, which though local is not infectious.

(b) Inflammatory œdema about the wound to a slight extent is not an uncommon occurrence. It is more likely to occur among poor ill-fed children in unwholesome surroundings and in hospital practice than among the well-to-do patients in private practice. Among the former it may occur after a perfectly well-performed operation, though I think it is more common after operations which have presented unusual difficulties or have been performed hurriedly or by inexperienced operators. When the operation has been done on account of laryngeal diphtheria with symptoms of general blood-poisoning such a condition may assume dangerous proportions. In nearly all cases of diphtheria there is a little swelling, and the edges of the tracheal wound may for a few days assume an unhealthy condition.

In some few cases, however, this inflammatory œdema spreads far beyond the limits of the tracheal wound; it may be chiefly confined to one side of the neck, more commonly it affects both sides and appears to be due to the gravitation of inflammatory products into and between the deeper ramifications of the cervical fascia; when it occurs on one side it will be so because the child preferentially lies towards that side and possibly also because the inter-muscular planes have been more freely opened up on that side at the operation. It is a condition closely allied to the disease named cellulitis of the neck or Angina Ludovici, after Dr. LUDWIG, the physician who first accurately described the disease, differing chiefly from this latter in that it is traumatic and secondary, and not spontaneous, as is the true Angina Ludovici, for a history and description of which I would refer the reader to my papers in the 'Lancet' October 18th and 25th, 1879.

In the milder degrees, this inflammation occurs in nearly all cases of tracheotomy and especially in the asthenic form of the disease, while in a few it assumes the pseudo-diphtheritic (membraniform) character already alluded to. The normal distance from the surface of the neck to the trachea is very greatly increased by this swelling of the tissues, as may be well seen when the cannula has been removed for the purpose of being cleaned. This swelling, again, is sometimes so great that there is difficulty in retaining the cannula *in situ*, and it is well for the surgeon to be provided with tubes of varying lengths ready for this emergency.

CASE. Diphtheria—Tracheotomy—Acute oedema of neck—Its treatment—Recovery.—J. W—, æt. 3, a pale, flabby child, was admitted, under the care of Dr. WEST, into the Hospital for Sick Children, suffering from diphtheria. In this case there was no difficulty at the operation, the trachea being rapidly and fully exposed before being incised. The child was completely relieved by the operation, and for the first few days appeared to be doing very well. But his temperature remained high. On the fourth day after the operation he was obviously less well, and there was an amount of depression which caused us considerable anxiety. There did not appear to be any chest complication to account for this. On removing the tube, the edges of the wound were found to be gaping and oedematous, and there was a copious and offensive tracheal discharge. On the fifth day an inflammatory oedema of the anterior part of the neck supervened, and rapidly increased in extent, so that the chin, neck, and sternum presented one continuous level. The tissues were brawny, and slightly reddened. There was a troublesome cough, and at each effort the tube was dislodged from the trachea, upon which a 'choking fit' immediately supervened. Owing to this swelling, our longest tube barely sufficed to reach the trachea, hence it had to be constantly held *in situ* by a nurse, but the boy was, nevertheless, nearly suffocated on several occasions. Fortunately the inflammation, having got to this stage, began to recede, and there was neither sloughing nor suppuration. We diligently applied lead lotion made with milk. One drachm of liq. plumbi was mixed with one ounce of fresh milk; this mixture

forms into a cream, and it was applied with a camel's-hair brush. Internally we gave tonics and stimulants. He was kept in the croup bed, and made to respire moist warm air containing creasote. We were not able finally to remove his tube until the twenty-sixth day after the operation, and then only after many unsuccessful previous efforts. The boy remained weak and anæmic for some months after his discharge from the hospital.

I have seen this inflammatory œdema affect the whole space included between the anterior margins of the sterno-mastoid muscles. The neck becomes brawny and hard, pitting slightly on pressure, and of a dull red colour. On dissecting a fatal case of this kind the inflammation is found to follow the ramifications of the deep cervical fascia; the cellular tissue between the various muscles is chiefly affected and its meshes are filled with a stinking ichor; in very severe cases the muscles themselves also become infiltrated and necrotic, the skin is rarely affected, and then only secondarily. This inflammatory process sometimes passes down into the mediastinum and may even affect the pericardium. Some authors (TRENDELENBURG and MAX SCHÜLLER, among others) appear to think that such a complication is more likely to follow the low than the high operation. Nevertheless most of the cases of cellulitis which have come under my own observation have followed the high operation.

(c) Erysipelas.—The form of cellulitis just described must not be confounded with erysipelas, another wound complication. The latter commences on the surface and is chiefly throughout superficial, though the deeper parts become subsequently affected. The skin is reddened, may be vesicated, and it may slough; there are the characteristic raised edge and the spreading margin; it may run on to the shoulders and front of the chest, or over the face and towards the scalp. In this respect it differs from Angina

Ludovici, which is always strictly limited, and shows no tendency to spread superficially.

CASE. Diphtheria — Tracheotomy — Erysipelas — Death from general infection. — Emily B—, æt. 3½, came under my observation in May, 1875, suffering from pharyngeal and laryngeal diphtheria. The symptoms began to manifest themselves three or four days before admission. When first seen there was erosion of both tonsils; the free margin of the epiglottis was coated with membrane, and there were scattered about the pharynx and uvula patches of greyish white membrane. The voice was quite gone; the child much depressed; the temperature 102° F. There was no pain or swelling in the neck. Her breathing became much more laboured within the next twenty-four hours, and tracheotomy was performed. Stimulants, with bark and ammonia were ordered. She remained drowsy and depressed. The urine contained one third albumen. Two days later, the child's general condition not having at all improved, the neck was found swollen and around the margins of the wound, there was a bright erysipelatoïd blush, with two or three vesications on its surface. The wound smelt badly, and appeared indolent and sloughy. Boracic acid in glycerine was freely applied to the wound. The erysipelas was coated over and beyond its margins with collodion, and on this again lint soaked in lead and milk was laid. Notwithstanding all our care, however, the erysipelas spread, and the general blood-poisoning became more and more intense; the child died on the third day after the operation.

To all intents and purposes, however, these two last named diseases are identical, for although their mode of onset and their exact etiology may be widely different, yet the inflammatory process once set up can hardly be differentiated. The prognosis in either case is not favorable. Even the milder forms of the disease may be considered as indicative of a low asthenic condition of the patient, while the severer forms are always associated with severe blood-poisoning. The most appropriate general treatment consists in the administration of brandy-mixture or bark and ammonia to sustain the patient; as local treatment I know of no better

application than a little glycerine of carbolic acid from time to time ; it helps to destroy the infectiveness of the wound secretions, while as a constant dressing glycerine and boracic acid will be found both healing and disinfectant. To the inflamed parts around the wound I usually apply lead and milk (a few drops of liq. plumbi in a little fresh milk). In the severer cases, incisions may be made to relieve tension ; it is seldom that pus collects in any quantity, but the incisions give exit to a thin foetid serum, and to the necrotic fibrous sheaths, and in this manner help to stay the spread of the disease.

If the erysipelas show any tendency to spread beyond the limits of the neck, the application of tincture of the perchloride of iron, or of an ethereal solution of nitrate of silver is indicated ; it should be painted over not the diseased part only, but for some distance in all directions beyond it. Then lead lotion over this.

In all the foregoing cases I venture to think that the croup bed with its supply of warm, moist, disinfecting fresh air will be found of the greatest utility. If employed from the first I think there is much less risk of the occurrence of such complications, while in the later stages the diseases are favourably modified.

The occurrence of such conditions without may often be regarded as evidence of what is taking place within the trachea, and they are a powerful argument in favour of the local treatment of the trachea and larynx, not only with a view to prevent their onset, but also to arrest them when present. It seems somewhat remarkable that TROUSSEAU should have advocated such heroic measures to prevent the spread of the diphtheria to external parts, and yet as regards the interior have taught "that when once tracheotomy has been performed, we need not further occupy ourselves with the pharyngeal or the laryngeal

manifestations of the diphtheria which claimed such energetic treatment previous to the operation. They get well of themselves.”

(d) Surgical emphysema starting from the neck is now and then met with after tracheotomy. It is usually ascribed to the escape of air from the trachea, through an opening in the trachea which does not quite correspond with the opening in the structures in front of the trachea. Although I have many times seen the trachea incised—sometimes in more places than one before it has been quite exposed—I can only call to mind two occasions in which emphysema has occurred. I am therefore inclined to seek for an explanation in some other direction than this. It must be remembered that when tracheotomy is being performed for diphtheria or other mechanical impediment to respiration, very little air is entering the larynx, and there is therefore but very little to pass out into the cellular tissue about the neck. On the other hand, violent inspiratory efforts are being made to obtain air, and more less of a vacuum produced in the chest as the result of not obtaining it. In this way a considerable quantity of air may be sucked into the cellular tissue, if the operation be unduly prolonged ; this is evidently more likely to occur when the low operation is performed. Many authors—especially German authors—have written on this subject, and quite recently Dr. CHAMPNEYS has made some interesting communications to the Royal Medical and Chirurgical Society on the subject of mediastinal emphysema with and without tracheotomy, to which the reader is referred for further details. I am the more doubtful that the air comes from the windpipe because of its harmlessness ; it appears to be rapidly absorbed and to lead to no bad consequences in the majority of cases. The following case is illustrative of this condition :—

CASE.—I was asked late one evening to see a little boy, *æt.* 2. On the previous day he had developed measles, and about the same time symptoms of diphtheria (a disease which not infrequently complicates the exanthemata). The breathing became so severely implicated that it was necessary to perform tracheotomy. The lower operation was determined upon, and proved to be a very difficult one, partly on account of hæmorrhage, and partly on account of the very rapid and laboured breathing; the tube could not be inserted. Under these circumstances I was sent for. I found the child very blue in the face, breathing rapidly and ineffectually; the trachea was partially exposed and with each expiration a few bubbles of air escaped through the external incision; there was extensive emphysema around the neck, extending upwards towards the face. With the consent of the other surgeons present, I extended the external wound a little higher up, and, disregarding the existing opening into the trachea, incised the two upper tracheal rings as well as the cricoid cartilage, and after clearing away all shreds of membrane and the accumulated mucus, I inserted a cannula without difficulty and with complete relief to the embarrassed respiration. The emphysema completely disappeared within a day or two.

For the moment, and following tradition, I was inclined to regard the emphysema as the direct result of the escape of air through the opening in the trachea, but on further consideration, and in the light of Dr. CHAMPNEYS' experiments, it now appears to me as more probable that the air was sucked in through the incised tissue towards the close of the operation before the trachea had been sufficiently opened to permit of free respiration when the dyspnœa was at its worst, and while the patient was in the constrained position which the operation involves. I would not argue that in a few cases the emphysema may not be produced by the escape of air from the trachea; the foregoing observations apply chiefly to the case just related. Whatever be its exact mode of production, however, the moral is the same, and needs but little emphasizing on my part.

(e) Total absence of healing power.—In a few

cases among poorer children there will be found a total absence of all recuperative power; the wound will remain gaping, pale, and flabby, and show no sign of granulating. I have seen three or four such cases at the Children's Hospital, Shadwell. The patients come from a very poor class of the population. In the case related below every possible sort of stimulant was tried without any success. The wound could not be got to show any signs of repair.

CASE.—Diphtheria—Tracheotomy—Regurgitation of food through tracheal wound—Total absence of all reparative power—Death on twenty-fifth day after operation, and nineteenth after removal of the tube.—**Matilda R—**, æt. 3, a pale, thin, delicate deaf and dumb child, first showed symptoms of diphtheria on April 6th. She was admitted under the care of my colleague, Dr. **EUSTACE SMITH**. The symptoms rapidly became well marked, and patches of membrane over the soft palate and tonsils with a livid ulceration were found. The glands at the angles of the jaws became much enlarged (they ultimately suppurated and discharged stinking pus). There was also a copious muco-sanious discharge from the nostrils. On the 8th the child was hoarse; she had a barking croupy cough, and there was slight recession of the chest walls. On April 10th all the symptoms had increased in severity, notwithstanding active treatment. **Mr. BATTAMS**, the Resident Medical Officer, therefore opened the trachea above the isthmus; membrane was feathered up. The child appeared to go on very well for five or six days; the active manifestations of the diphtheria cleared up; there was no further deposit of membrane; the ulceration in the pharynx began to heal. The child's appetite, however, remained bad. On April 16th she quite refused all solid or semi-solid food; while liquid food passed into the pharynx and came out through the tracheotomy wound. The child was exceedingly weak and apathetic, very pale and blanched, but free from pain or discomfort. In the chest there was some slight bronchitis; her temperature was low. **Mr. BATTAMS** tried feeding by means of a tube passed into the stomach through the nostril, and from April 18th she was fed in this manner entirely until her death, which took place on May 5th, of gradual exhaustion and a low form of spreading pleuro-pneumonia. The child never resisted being fed; she laid back in the nurse's arms quite indifferent;

her medicine was also given in this manner. The tracheal wound looked pale; its edges were somewhat everted, glassy and flabby; from the first it never showed the slightest tendency to granulate or heal; nevertheless, it did not appear unhealthy, and the discharge from it, a pale watery fluid, was quite free from odour. Various kinds of dressing were tried in turns without any good effect.

This was the feature of the case. The *post-mortem* examination revealed pleuro-pneumonia on both sides. There was no erosion in the trachea, and all signs of membrane had disappeared. Two other members of the same family had also died of diphtheria.

The only other possible remedy which was not tried in this case was complete change of air. But, in similar circumstances, if such a change could be secured for a child in this asthenic condition, I should strongly recommend its being tried. Sea air has in some few cases a marvellous effect. Short of this, let the child be carried out for half an hour's airing, the neck being carefully protected from cold by several thicknesses of gauze.

2. THE REMOTE COMPLICATIONS.

(a) *Acute or subacute changes due to the lesion, for which tracheotomy has been performed.*—In severe cases of diphtheria there is sometimes found deep ulceration with excavation of the mucous membrane after the false membrane has been detached, a condition which may be found at any part of the larynx. Such ulceration is usually accompanied by swelling of the adjacent sub-mucous tissue, and the ulcers themselves not infrequently become covered with florid flabby granulations, which are very troublesome to heal. This thickening of the sub-mucous tissue may also be directly continuous with that in the pharynx, and independent of ulceration.

After scalds of the glottis it invariably exists for a

longer or shorter period, and in greater or less intensity. It is this swelling that leads to the obstruction to breathing (not seldom fatal) which is known to occur after apparently slight scalds of the pharynx and larynx. At the present time I have under observation a child who was tracheotomised four or five years ago for laryngeal obstruction following a not very severe scald of the glottis. Several attempts to dispense with the tube have been made, but hitherto without success.

In the laryngitis which is occasionally associated with congenital syphilis the lesion is of a rather different kind; it more resembles the mucous patches which occur in the mouth and about the lips. The membrane is thickened and raised owing to its infiltration with cells; the sub-mucous tissue of course partakes more or less in the change. In older children occasionally a destructive phagedænic ulceration may occur either primarily in the larynx, or by extension from the arches of the palate or epiglottis, or from the wound.

In perichondritis such as is met with in a few cases as a sequela of typhoid fever and of other febrile conditions, the inflamed mucous membrane is symptomatic of deeper changes rather than a primary condition; its course, clinical manifestations, and treatment will depend on the primary lesion. A form of laryngitis occurs also occasionally after febrile conditions, and the exanthemata, apparently due to the breaking down of exudative material which has collected in the glandular structures of the mucous membrane, probably of the same nature as typhoidal ulceration in the intestines.

These local conditions, which may all give rise to dyspnoea and necessitate the performance of tracheotomy, will generally persist for some time after the operation; the surgeon is usually brought face to face with his case

when the dyspnœa is so urgent that the operation must be performed at once, and the diagnosis made afterwards. It is in such cases that the foregoing conditions become complications, the full significance of which will only become apparent at the end of a few days, when, the urgent dyspnœa having been relieved, the question of removing the cannula begins to present itself.

The diagnosis of the various conditions is not very difficult, but it is essential to successful treatment. The ulceration which diphtheria occasionally produces may be suspected in the larynx, if respiration through the glottis is delayed for some time after the general disease has subsided, and more especially if a similar condition has been seen about the tonsils or palate or external wound. The expectoration of bits of membrane or of pellets of inspissated mucus with shreds of necrotic submucous tissue attached and blood-stained on the deeper surface occurs from time to time, and makes such a diagnosis almost certain. In most cases of this kind among young children there will be considerable delay in laying aside the silver tube; if the child be poor and ill nourished, this ulceration may heal very slowly, and months may pass before the laryngeal function is re-established. In syphilis, a diagnosis which has often to be made by a process of exclusion, improvement will rapidly set in on an antisiphilitic treatment, while the condition will remain stationary or become aggravated if merely treated by general remedies. Apart, however, from this method of diagnosis there may be a history of congenital syphilis, and perhaps also evident syphilitic lesions of other organs; thrush in the mouth, snuffing, condylomata about the anus, local thickenings on the long bones or bones of the skull. Any such signs would be in the highest degree suggestive of the probable nature of the

laryngeal lesion, if laryngeal obstruction were found associated with one or other of the above-named conditions. In doubtful cases a mercurial course can be tried if the laryngeal urgency is not very great; a few days at most will suffice to test the value of such treatment. Finally, it must not be forgotten that diphtheria may supervene, as a complication, on these foregoing conditions; that indeed chronic inflammatory conditions of the larynx and pharynx rather predispose to attacks of diphtheria.

The action of corrosive fluids and of hot steam or water varies with the amount swallowed, with the nature of the fluid, and with the heat of the water or steam. Occasionally diphtheria, or a membraniform inflammation which is indistinguishable from diphtheria,¹ may attack a throat so injured; in which case treatment will have to be in accordance with general principles, as already laid down. If the laryngeal cartilages become diseased they will have to be removed, and the ulceration of the adjoining mucous membrane will probably not begin to repair until their removal is accomplished; furthermore, the necrosed cartilage may become detached and fall into the air-passages unless it is removed. The history of a case should be carefully ascertained in all instances, not only for purposes of differential diagnosis, but for treatment also.

For the purposes of local applications, whether disinfectant, astringent, or solvent, to the throat, nothing is so effectual as a good spray. I would especially urge the value of a steam spray. The greater power of this over a hand spray ensures a finer pulverisation of the fluid which is being used, and it is thus more easily and more thoroughly brought into contact with every part of

¹ For a case of this kind which I have recorded, *vide* 'Clinical Society's Transactions,' vol. viii, 1875. For a similar case, by Mr. DAVIES-COLLEY, see 'Pathological Transactions,' vol. xxxiii, 1882.

the diseased membrane, even up in the posterior nares. In cases of diphtheria where solvents are being used to destroy false membrane, a steam spray is of first importance. By causing the patient to inhale through the larynx, or making him attempt to do so, the spray reaches the glottis and materially assists in getting rid of the viscid mucus or membrane which tends to collect at this spot. Occasionally, however, strong solutions of nitrate of silver are required, and these of course cannot be sprayed in. For such cases I have found the little instrument



FIG. 15.—An instrument for applying solutions to the larynx through the opening in the trachea.

figured above very useful. It can easily be made, and bent to any angle most convenient to the requirements of the case. It consists of a piece of glass tubing bent in the flame of a spirit lamp to the required shape, to the end of which an india-rubber mouthpiece is attached. When about to be used, a little nitrate of silver solution of the required strength is put into it; the pointed extremity is passed through the tracheal wound up to the larynx, and the fluid is blown out through the india-rubber tube. By its use the fluid is brought to bear directly on the part affected.

(b) Chronic catarrh.—In children, the chronic conditions which may demand tracheotomy are: (a) chronic laryngitis, and (b) warty laryngitis (papilloma). From a consideration of the pathological anatomy of these conditions it will at once be evident that obstruction to the breathing may sooner or later come on, and how and why a little fresh catarrh or the occurrence of an exanthem or of whooping-cough may suddenly render these conditions

of very serious import, and introduce an element of danger which will be great in proportion to the youth of the patient.

(a) Chronic laryngitis is usually secondary to an acute attack; and when it attacks the larynx, in a majority of instances it is by direct extension from the pharynx, or it depends on some constitutional peculiarity. Chronic catarrh leads to enlargement of the racemose glands and to general thickening of the mucous membrane and submucous tissue; the calibre of the larynx and trachea is thus narrowed; moreover, there is increased secretion of mucus, which is very tenacious, hard, and difficult to cough up. Owing to their small size in early life, stridor and dyspnoea quickly supervene on the slightest exacerbation of the conditions—such as that produced by simple catarrh, for instance. In other cases the onset of dyspnoea is very gradual; it is at first most obvious during the night when the child is asleep, and little by little as it progresses sleep becomes much disturbed. The stridor then becomes audible during the daytime, and is worse after crying or emotion of any kind. On examining the chest, the soft parts will now be found to sink in with respiration, and in children old enough to talk an alteration in the tone of the voice will become noticeable. Gradually the breathing becomes more and more laboured, and the voice, which is hoarse from the first, is finally suppressed. The following is a typical case.

CASE. Chronic laryngitis — No obvious cause — Urgent dyspnoea — Tracheotomy — Difficulty in removing tube—Recovery.—C. B—, a little boy, *æt.* 4, was readmitted into the hospital on account of an increasing dyspnoea. He had already been under observation a few weeks previously for the same condition, for which he had been successfully treated with iodide and bromide of potassium, and local astringents. The condition had come on so gradually

that the exact date of its first onset could not be fixed. At first it was chiefly noticed at night; then became evident during the day; there had, however, been slight exacerbations from time to time whenever the boy cried or caught cold; his voice had been hoarse for some time past. At the time of his readmission his symptoms were almost urgent; his pharynx on examination was swollen and congested; the epiglottis also appeared thickened; the voice was hoarse and half suppressed, and he spoke with great effort. He was immediately placed in a croup bed, and sedatives were added to the warm moistened air he was made to breathe; after a while he improved slightly. His dyspnoea was always worse at night; for two or three nights after his admission, between 11 p.m. and 2 or 3 a.m., the breathing was so laboured that tracheotomy seemed unavoidable. However, towards morning, the violence of the attack passed off, and he slept in comparative ease. Matters continued like this for a week, and as there was no permanent improvement in his condition, tracheotomy was performed. Subsequently he did well; his anxious, careworn expression gradually wore off, he slept soundly, his appetite and spirits and strength returned. I need not detail all that transpired within the next three months, during which he had to wear his tube. We tried his breathing power on several occasions, but he could not get on for very long without his tube. The boy was of a highly nervous temperament, and he greatly dreaded its removal. A subterfuge was finally adopted; a window was cut in the tube just at the angle, and the external orifice was corked; this obliged the boy to breathe through the glottis, while the presence of the tube in the trachea lessened his nervous agitation. To this he gradually accustomed himself, and little by little also he learned to sleep with the tube corked. Meanwhile his throat was sprayed with astringent applications, and the sub-inflammatory condition at last subsided; the boy also grew considerably. Finally, after many failures, we succeeded in removing the cannula; but his inspiration continued noisy for many months, though it had ceased to be laboured. His general treatment consisted in a liberal diet, with cod-liver oil and steel wine.

In many similar cases which I have seen at various times the nocturnal exacerbation of symptoms has occurred; the crisis is reached between two and three o'clock in the morning; the difficulty then appears to have expended itself, and comparative ease and quietness follow.

(b) Warty laryngitis (Papilloma).—Dr. M. MACKENZIE, in his work on 'Diseases of the Larynx,' p. 300, says, "Chronic congestion of the laryngeal mucous membrane is, far above all other causes, the most important etiological feature in the production of simple morbid growths in the larynx." In the following two cases there was no very manifest cause, but the social surroundings of the patients were just such as would favour the onset of chronic catarrh in children with a predisposition thereto. I am inclined to attribute greater weight to personal predisposition than to chronic congestion, which is itself a morbid condition. Among poor children chronic laryngeal catarrh (chronic congestion) is common, while warty laryngitis is very uncommon. Warty laryngitis is occasionally congenital; I have myself seen one or two instances in the bodies of children who have died of other complaints, and before the local condition had had time to manifest itself.

CASE. Laryngeal catarrh—Increasing dyspnoea—Tracheotomy—Warts seen on vocal cords through tracheal wound—Perfect relief by operation—pneumonia three months later—Death—Autopsy.—W. C., aged twelve months, was a small, careworn-looking child when he first came under observation. The mother's account was that the disease began nine months previously when the child was between three and four months old; she thought he had caught cold. This was followed by wheezing. Six months ago (at Christmas time) the child lost his voice, his cough became croupy, and he began to breathe with stridor. This stridor gradually became more marked, and during the last four months it had been so bad during the night that the child had only been able to sleep for very short periods during the whole of this time. There was no history of phthisis nor anything reliable of syphilis. When first seen he was greatly emaciated and looked exhausted. The child seemed drowsy and tried to sleep, but the difficulty of breathing roused him at once. The breathing was very laboured and stridulous, the cry almost inaudible. With each inspiration there was recession of the epigastrium

and of the episternal region ; expiration was comparatively easy. The fauces were congested ; the tonsils also, but not enlarged. The skin was of a livid pallor. The child was put into the croup bed, and steam, with creasote vapour, was turned in. There was no amelioration ; on the contrary, at five o'clock in the morning, the breathing having become exceedingly laboured, tracheotomy was performed. The relief was immediate and complete. On examining the trachea through the wound, held open by double blunt hooks, a crop of sessile warts could be distinctly seen on and about the vocal cords. A cannula was then put in, and the child returned to bed, when he slept soundly for some hours. Within a few days general improvement set in. He could now sleep well, and he took food with relish : the wound in the neck healed, save a channel for the tube, which we did not even try to remove under the circumstances. For two months the child thrived ; then he got pneumonia and died rapidly.

In this case the history pointed clearly to a chronic condition, and all doubt as to its real nature was set at rest by the examination of the larynx at the time of the operation. The child was so young and so small that the question of thyrotomy was only entertained to be discarded, for apart from the serious nature of the operation, the scattered sessile condition of the growths would have added materially to the difficulties of the operation. The condition of the larynx, as found after death, is depicted in Fig. 16. Microscopically these warts were found



FIG. 16.

to consist of delicate nucleated fibrous tissue. Our atten-

tion was chiefly directed to the general health, which had suffered very much from want of sleep. We were especially careful to provide him with a well-fitting tube. This was changed from time to time, sometimes a long tube, sometimes a shorter one, being used. As will be seen, there was no ulceration from the tube below, but above a quantity of granulation tissue had formed itself into something like a membranous diaphragm which easily broke down when touched.

Another case of papilloma of the larynx came under my observation quite recently. The history of the case differs considerably from the last; the child was older, but the exact nature of the obstruction was not made out until after death.

CASE. Chronic laryngitis—Progressive stridor—dyspnœa—Tracheotomy—Measles three months later—Death—Autopsy—Papilloma of larynx.—Annie D—, æt. 3½, was admitted into the East London Hospital for Children in November, 1882, under the care of my colleague, Dr. DONKIN, with a history "that she was well one day and her voice gone the next." The condition of the voice was slowly getting worse week by week, but she was not ill in herself. On admission, the breathing was stridulous and the voice hoarse; there was recession of the soft parts of the anterior part of the chest. The tonsils were very large; they almost met in the middle line. The diagnosis was chronic catarrhal pharyngo-laryngitis. Every kind of treatment, both local and constitutional, was tried for some weeks without any good effect; her voice gradually became weaker, and her dyspnœa more severe. During an attack of pneumonia, from which she suffered in the following February, her dyspnœa became so urgent that Mr. BATTAMS, the Resident Medical Officer, had to perform tracheotomy. She went on well and seemed relieved of all her dyspnœa, but the voice in no way improved. Many attempts to remove the tube were made, but were unavailing. In process of time she was got up and allowed to play about the ward, and in suitable weather she went out into the garden. In May she caught measles, which was then epidemic in the neighbourhood, on which broncho-pneumonia again supervened, and

she died on May 26th, still wearing her tracheotomy tube. The autopsy revealed extensive pneumonia, and the condition of the

larynx is depicted in the annexed drawing. It will be seen that there are two large cauliflower-like warts on the left vocal cord, with a crop of smaller warts on the right cord, and scattered about the larynx generally. There were some small flabby granulations around the inner orifice of the tracheotomy wound, but no ulceration in the trachea.



FIG. 17.

In this case a correct diagnosis would have been of interest, and possibly of service, but the history was insufficient for the purpose; the condition of the tonsils and pharynx generally precluded the use of the laryngoscope, even had

the age of the patient not done so to any but such skilled laryngoscopists as MACKENZIE or SEMON. But a diagnosis might probably have been made from the tracheal wound at the time of the operation had the attempt been made. It is even possible that the warts might have been snipped off; at any rate, the larger warts, which were more or less pedunculated, could have been removed without much difficulty. It is of course doubtful whether the smallest ones could have been removed, but it is equally doubtful whether they were present at the time the tracheotomy was done. I am inclined to think that they may have grown subsequently in response to a long-continued irritation of a mucous membrane with warty proclivities. Such cases, when they can be diagnosed

should be taken in hand at once. Nothing is gained by waiting; the warts spread, they grow larger, and every subsequent operative interference beyond the first one adds to the dangers and uncertainties of the case. If the diagnosis of warts in such a case as the foregoing can be made with certainty, an attempt to remove them one way or another should be made. Since writing this, a case has come under my care in which I have performed thyrotomy and removed an immense crop of warts filling the interior of the larynx. The child, aged four years, has done well; her voice is fairly good, and is daily gaining in power.

(c) Irritative changes due to the presence of a tube.—In a few cases the mere presence of a tracheotomy tube in the trachea, even when perfect as regards length, shape, and size, appears to give rise to an irritation which is quickly followed by the growth of granulations. A considerable amount of granulations has been found in from four to eight days in cases which have terminated fatally. Such a condition may be suspected if the insertion of the tube appears to cause undue irritation, and especially if its insertion is followed by blood-stained secretion. The use of the feather also causes very considerable irritation, and has to be discontinued. In cases where the granulations about the external wound proliferate with unusual exuberance, such a growth may be suspected within. This peculiarity seems to depend on a hypersensitiveness of the tracheal mucous membrane, and it is an idiosyncrasy which must be taken into account. Minor degrees of this condition are often experienced, some tracheotomised children never reconciling themselves to the cleaning and changing of the tube.

If granulations spring up, the best treatment is the local

application of nitrate of silver. A silver probe, after being suitably bent and coated with fused nitrate of silver, is introduced into the tracheal wound, and made to touch as nearly as possible those parts on which the tube has rested. Or a few drops of a thirty-grain solution of nitrate of silver may be allowed to trickle into the trachea, the child sitting upright and inclined slightly backwards, so that the solution may run over the affected portion of the trachea.

The granulations I am now alluding to may occur all round the trachea, and not merely on the anterior wall or at one spot; for they are not due to pressure, but, as before stated, to the presence of a foreign body in an unusually



FIG. 18.

sensitive trachea. I append the drawing of a trachea (see Fig. 18) in which granulations due to this cause were very abundant over the whole track of the tube. There was no sign of ulceration; the granulations occurred within five or six days of the operation. The child appeared to be doing very well, until one night it was suddenly choked after a violent fit of coughing. The autopsy revealed the presence of granulations between the tracheal wall and the

tube, which doubtless during life were florid and turgid with blood, and completely filled the space; one currant-like granulation, larger than the rest and attached to a small pedicle, had apparently been driven by the coughing into the tube and completely occluded it.

In the case of warty laryngitis—that is, when there is

a natural tendency to the formation of warts—the irritation of a tube leads to the production of minute warts, instead of granulations proper, as seen in Fig. 16 below the tracheal opening. In the case of granulations proper, some difficulty is usually met with in the removal of the tube. At first sight the obvious remedy is the removal of the cause ; but an acute obstruction having necessitated the use of the tube, granulations having occurred and actually existing, the difficulty arises of how best to treat them. Such cases all point to the desideratum of tracheotomy without the use of tubes at all. At present, I have not been able to dispense with them ; nor do I know of any trustworthy means of gaining the desired objects without tubes ; at the same time it is a desideratum I constantly have in mind, and which I recommend to the consideration of my professional brethren.

As to treatment, reference has just been made to the use of nitrate of silver once a day, or once in two days. The alum spray or tannin spray (an ounce of tannic acid glycerine in seven ounces of water) must be used at frequent intervals through the day and night. The tube should be removed for as long as possible, and the silver plug inserted, the patient being meanwhile under direct supervision ; for on the removal of the tube, the granulations swell out, and if present in quantity they in time occlude the trachea. Hence in a few instances a child will breathe well for an hour or two, then the tube must be reinserted. The explanation appears to be as follows. The tube by its presence keeps back the granulations, but having been removed, they commence to swell up ; possibly also the more laboured breathing (which follows the removal of the tube), by causing congestion, helps them to still further occlude the trachea. Cauterisation and astringents are the best remedies, and are generally successful.

(d) Ulceration in the trachea, due to ill-fitting of the tube.—This condition is now of much less frequent occurrence than formerly. M. ROGER was the first to draw prominent attention to the subject, and to suggest at once the cause and the remedy.¹ As I have no personal cases to relate, I must summarise M. ROGER's views and conclusions. He showed that the complication was more liable to occur in some cases and in some epidemics than in others ; but from the anterior wall being most affected, and just at the place corresponding to the lower extremity of the tube, he argued that the chief cause of the ulceration was pressure of the tube, "*l'action vulnérante de la canule.*" This condition is most to be feared when the tube has to be worn for a longer period than usual, but it has been found as early as thirty-six hours after the operation. The ulceration may be only superficial, or it may be deep enough to perforate the trachea, and, as cases are recorded in which the innominate artery has been opened, it will be allowed that this complication is a very formidable one. As symptoms of this form of ulceration, M. ROGER gives the following. It is to be suspected if the external wound assumes a sloughy condition, and if the breath and expectoration become foetid, the tube will be blackened, either entirely or in patches, and there may be pain or difficulty in swallowing. Most of these symptoms, however, may occur without the presence of ulceration, as I have seen on many occasions. The difficulty of recognising the onset of this ulceration, no less than its dangerous nature, render it incumbent on the surgeon to watch his patient closely on the one hand, and on the other only to use such tubes as are comparatively safe and unlikely to press on the trachea.

M. ROGER tried different materials—gutta percha, india

¹ 'Archives Générales de Médecine,' 1859, vol. ii.

rubber, flexible ivory ; but finally discarded them in favour of silver, recognising that the ulceration depended on the unsuitable shape of the tube, rather than on the fact of its being rigid : " *La forme des canules habituellement en usage n'est pas celle qui conviendrait le mieux* " (p. 180, op. cit.). After many unsuccessful trials, M. ROGER finally adopted LÜER's tube with the movable collar.

While admitting the immense improvement which was thus effected, as already stated I am inclined to think that much of the mischief was really due to the quarter-circle shape of the tube itself. I must refer the reader back to what has already been said on the subject of tubes. Since using the ' angular ' tube, I have not had any cases of ulceration to report.

CICATRICIAL NARROWING.—Narrowing of the trachea is occasionally met with. Its occurrence is possible after tracheotomy, where there has been much sloughing or destructive disease, either in the trachea or around the incision into it. I have seen one case where stridulous breathing, years after the operation, probably indicates this pathological condition. The treatment of such cases, to be of any avail, must commence early ; even then it is not very satisfactory. It should consist in the passing of graduated bougies, hollow, so that respiration can be carried on during the process of dilatation. Better still will be the adoption of such measures as will prevent its occurrence. These have been already referred to in the preceding paragraphs.

(e) *Accidental conditions.*—Under this heading I shall include two cases, which, though not by any means unique instances, are nevertheless so rarely met with as to require separate consideration. They appear so purely accidental in their incidence that none but the most general precautions can be taken to guard against them.

CASE. Catarrhal laryngitis—Tracheotomy—Difficulty in removing tube—Hypersensitiveness of the trachea—Death in convulsion fifteen days after removal of tube—Autopsy—Large granuloma at the seat of cicatrised wound inside the trachea.—Eliza M—, æt. 2½, was admitted into the hospital under the care of my colleague, Dr. EUSTACE SMITH, on February, 1882. She was one of eight children, of whom one had recently been suffering from quinsy. She had enlarged glands about the neck, secondary to eczema capitis, to which disorder she was very subject. She was a plump, well-nourished child, and well-grown for her age, with no very manifest signs of rickets. On admission she was said to have been hoarse for two days; she had that morning complained of having 'a pin in her throat.' She had had no discharge from her nose, and there was no illness in the house. Her breathing had become so laboured by the following day that tracheotomy had to be performed by Mr. BATTAMS; the high operation was done; chloroform was adminis-

tered by Mr. SANDERSON, one of the resident officers. No membrane was got up or seen. The child did fairly well; efforts to remove the tube, however, were not successful until March 15th, thirty days after the operation. It was remarked at the operation, as well as subsequently, that the child's trachea was remarkably sensitive; she coughed violently whenever it was necessary to clear the tube or attend to the wound, and one of the difficulties which attended the attempts to remove the tube appeared due to this hypersensitiveness of the tracheal mucous membrane. Finally, the tube was removed, and the external wound gradually closed up. The child breathed fairly well in the



FIG. 19.

daytime, but had attacks of urgent dyspnoea, becoming progressively worse during the nights, with some nights of comparative immunity. The voice was not hoarse. On March

31st, forty-six days after the operation, the child died in a convulsion after an attack of dyspnoea rather worse than usual. The trachea was again opened, but too late to save life. The autopsy revealed the condition depicted in Fig. 19. At the site of the old tracheal wound was a highly vascular livid mass of granulation, more or less pedunculated, projecting into and considerably narrowing the trachea at this point. The ary-epiglottic folds were very œdematous.

In this case the laryngo-tracheal mucous membrane was exceedingly sensitive, and doubtless also somewhat œdematous. Thus breathing was rather more laboured than normal after the tracheal tube had been removed. The granuloma doubtless gradually developed and increased in size, and finally, during an unusually severe paroxysm of laboured breathing, it became extra turgid, and so completely occluded the cricoid opening (which is the narrowest part of the windpipe), and thus killed the child. A fatal termination to a case of tracheotomy from this cause may be regarded as a rare event. Dr. PETEL, in his graduation thesis,¹ only collected ten such cases in addition to the one he himself recorded. In three of the cases a second operation was performed with complete success. In one case the child was tracheotomised three times, and had still to wear the cannula. In another case the polypoid granulation was spontaneously coughed up. In three cases death resulted before help could be given. In two cases the condition, which had not given rise to any symptoms, was only discovered at the autopsy, death having taken place from some other cause. In a minor degree, nevertheless, I am inclined to think that such a condition is not very uncommon. There are no *a priori* grounds why granulations should not spring up on the deep surface of the wound as they do on the superficial.

¹ 'Des Polypes de la Trachée, survenant après Cicatrisation de la Trachéotomie,' Thèse de Paris, 1879, No. 500.

On the latter granulations, sometimes very exuberant, are the rule. From a study of the published cases it appears that the granulations have most frequently grown from the upper angle of the wound—that is to say, immediately below the cricoid opening, the point where their presence would be most dangerous. The possibility of such an occurrence has even been urged, but I think the grounds very insufficient, as an argument against the high operation. This condition may be suspected—the patient having previously undergone tracheotomy, the tube having been removed, and the wound being more or less cicatrised—if the breathing again becomes gradually and temporarily embarrassed, the voice generally remaining unaffected. At first this embarrassment will be chiefly obvious at night, when the child is asleep; then during the day-time also. It will be paroxysmal, and vary much in intensity; in the later stages expiration will be as much impeded as inspiration (or more); there will probably be blood-stained expectoration, especially after paroxysmal coughing. It is probable also that the external wound may have exhibited a tendency to exuberant granulations. Given such signs, what is to be done under the circumstances? The surgeon will have to be guided by the intensity of the resulting dyspnoea; if it tends to improve slowly, the use of the alum or tannin spray may be continued; if it tends to become more marked, a second operation will have to be undertaken and an examination of the part made, with a view to the removal (if present) of the granulations by forceps, caustic or otherwise. In his interesting graduation thesis Dr. CARRIÉ¹ says, p. 63:—“In these circumstances, with difficulty [of breathing], recession, noisy breathing during the night, we must not

¹ ‘Contribution à l’Étude des Causes empêchant l’Ablation définitive de la Canule,’ Thèse de Paris, 1879, No. 13.

await a first access of suffocation, which may prove fatal, but at once re-open the trachea.”

CASE. ‘Croupy’ cough—Urgent dyspnœa—Tracheotomy—Inability to remove the cannula—Sudden death three months later—Autopsy—Web-like adhesion between the cords.—A little boy, eighteen months old, came under observation on account of a ‘croupy’ cough and dyspnœa, which subsequently necessitated tracheotomy. No membrane was got up. At the end of a week attempts to remove the tube were commenced. They were quite unsuccessful, and remained so. The child’s general condition was good, and he appeared well in all respects except that he could not get on without his tube. One night he was found dead in bed. No sound had been heard by the night nurse, who had just previously looked at him and found him sleeping comfortably. The bedclothes were quite undisturbed. His eyes were closed, and his features free from any sign of a death-struggle. The autopsy revealed the following condition. The lymphatic glands, tonsils, follicles of the pharynx, and root of the tongue were very much enlarged. On the anterior wall of the œsophagus, opposite the shoulder of the tube, there was an oval diphtheritic patch three quarters of an inch long, corresponding with a similar condition on the posterior wall of the trachea. Looking into the larynx from above, the vocal cords were seen to be much swollen. Looking up the trachea from below there was no visible passage; in fact, immediately above the tube there was a diaphragm of granulating and cicatrising tissue, which had a short, unattached margin opposite the posterior wall of the windpipe and nowhere else. This septum would impede inspiration greatly and expiration altogether. There was great ulceration of the mucous membrane opposite the end of the tube.

DIFFICULTIES IN PERMANENTLY REMOVING THE TUBE.—The one complication in common in all the cases just recorded was difficulty in removing the tube. In some of the cases this depended on mechanical causes such as would not in the nature of things be remedied by tracheotomy; while in others the difficulty arose from conditions which were mechanical and secondary to the primary lesions. In some the difficulties were not anticipated, and were in fact the symptoms which first led to a

diagnosis; in other cases experience taught us that difficulties might arise. There still remains a class of cases in which this difficulty occurs and persists a long time, and is not adequately explained by mechanical obstruction alone. The following is a typical case:

CASE. Diphtheria—Tracheotomy—Chronic pharyngitis—Delayed removal of tube—Scarlet fever—Albuminuria—Change of air to the seaside—Recovery—Tube finally removed 175 days after operation.—M. T—, *æt.* 2, a very delicate child, was tracheotomised on account of severe diphtheria. Other members of the family had suffered, though in a varying and less severe degree. The child had previously been treated with emetics. The operation afforded immense relief; flakes of membrane were spontaneously coughed out, as well as wiped out with a feather. On the day after the operation he had a troublesome hacking cough, which much exhausted him. He was accordingly chloroformed, the tube taken out, and the larynx and trachea were again carefully cleaned out, after which the tube was again inserted. Benzoin inhalations were then ordered, and he was much relieved for a time. The cough, however, returned from time to time, and a few whiffs of chloroform were given through the tube, shortly after which it passed off.

On the fourth day after the operation the larynx was tried and considerable breathing power found to be present. On the sixth day, with the tracheal wound closed, he spoke a few words quite distinctly. On the twelfth day little or no progress had been made. On the seventeenth day he could inspire a little and expire freely when the tube was out.

On the twenty-fifth day the tube was removed, and kept out for fifty minutes, the external wound being closed, without producing any great amount of distress, after which it had to be replaced. On the twenty-seventh day, and without any obvious change in the boy's condition, he could not breathe at all through the larynx, and the tube, which had been removed for the trial, had to be replaced very hurriedly. The boy's general health had been improving daily, and he was taken out when the weather permitted.

We continued to make these trials with a varying amount of success. Several differently-shaped tubes were made for him; some with, others without, a window, and the length as well as the curve were altered, so as to avoid intra-tracheal erosions.

When two months had elapsed, the external wound having cicatrised, except a narrow channel for the tube, a new complication set in. On removing the tube, this channel into the trachea (which was lined with young cicatricial tissue) gradually closed, so that after about an hour it was difficult to re-introduce the tube when the state of the breathing rendered it necessary. I therefore used a plug made of gutta percha (Fig. 20).

This plug just reached into the trachea, and so prevented closure of the external opening; but it was not long enough to interfere in any way with the respiration. We also had recourse to a short tube corked at its external orifice, with a large window in its convexity; the boy was thus made to breathe through his glottis. Thus we continued for another month, making way very slowly indeed. Although he got on well enough in the daytime, he could not sleep a wink at night without his tube. Galvanism of the muscles of the neck was tried without any good effect.

Exactly three months after the operation he contracted scarlet fever. Although there was no dangerous faucial complication, there was sufficient inflammation to undo all that we had gained during our attempts to remove the tube; in fact, we found it obligatory to desist from these attempts. At this time we had the advantage of a consultation with the late Dr. MURCHISON. When the fever was over, we recommenced our attempts to get rid of the tube, working exactly on the same plan; and, as before, with varying success. I may sum up by saying that the boy could breathe through his glottis with comparative ease (and could talk with considerable distinctness) while awake, but not at all when he fell asleep. In the fourth week after scarlet fever albuminuria supervened, and he became very low and ill. Somewhat later on he had a severe cough, and his temperature was high—on one occasion 105° F. Dr. ORD now gave us the benefit of his assistance. We feared that general tuberculosis might be setting in. However, under the influence of tepid bathing and the inhalation of sulphur vapour he began to improve. I then advised his removal to Margate, his father going with him and taking charge of him. He remained at Margate about a month, and he returned home greatly benefited in every way. His temperature had become normal, and all traces of albumen disappeared from the urine.

We again recommenced our attempts to remove the tube, adopting the tactics already described. Finally, we succeeded on the 175th day after the operation. The first night he had

to sleep without the tube was a very anxious time for us, for the boy seemed about to choke on several occasions. Fortunately we persevered. When his difficulties got beyond a certain point he woke up, and then his breathing became comparatively easy. These nocturnal difficulties came on again and again, and it was some weeks before he could sleep at all soundly. At the present time the boy is vigorous and strong, and has quite outgrown all his former troubles. I ought to state that the child was highly nervous, put himself into a passion, and cried very much whenever he saw me. He never got the better of this fear, although I had him under care for six months. I mention this fact because I think it helps to explain some of the difficulties of the case, especially the very variable results of the earlier trials at removal of the tube.

In this case there was a certain amount of local pharyngo-laryngitis, which rather impeded respiration at the first trials. But as this inflammation subsided some progress was made. The child, however, was very nervous, dreaded the removal of his tube, and cried the moment any attempt was made. This led to increased congestion and swelling, which still further increased his difficulties. On the supervention of the scarlet fever, further inflammation of the throat came on, and threw us back again. Some weeks had now elapsed since the operation, and probably the effects of disuse of the laryngeal muscles were added to the already existing difficulties of the case. Meanwhile, further complications showed themselves, and the general health of the patient began to fail. We now found it impossible to continue our trials, hence the child was sent to the seaside for a month, during which time no attempt to remove the tube was made. It was corked up during the day, so that the boy used the larynx both for breathing and speaking, being allowed to breathe through the tube at night. On his return home, strong and well, we at once reattempted the permanent removal of the tube, and after some unsuccessful trials we succeeded. Meanwhile upwards of six months had

elapsed since the operation ; the boy had grown in size considerably in the interval, and to this fact, as much as to any other, our success was finally due.

Cases similar to the foregoing are by no means uncommon ; but as no two of them are exactly alike, it is impossible to lay down a hard and fast line of treatment. Perseverance is the best weapon to use. In very young, anæmic, flabby children it may be well to desist from the attempts for a while. The size of the larynx and trachea is sometimes so small that success can only be looked for in their gradual growth and development. Meanwhile, attention must be paid to the general health, and especial care taken that the tracheotomy tube fits well, and that no tracheal erosions are adding to the original mischief within.

MENTAL AGITATION, as was pointed out by Mr. THOMAS SMITH¹ plays an important part in all these cases. Not infrequently a child will breathe comfortably either with the tube corked up or (after its removal) with the opening into the trachea closed by means of the plug represented in Fig. 20 for hours together ; he may even sleep quietly until some mental agitation (perhaps a dream) suddenly interferes with the rhythmical action of the respiratory apparatus, and necessitates the immediate institution of the silver tube. In such cases the silver plug will be

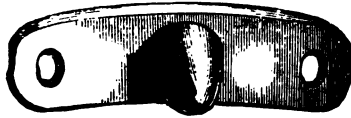


FIG. 20.—A Silver or Gutta-percha Plug.

found very useful. It just reaches into the trachea, and so prevents the external opening from closing when the

¹ 'Medico-Chirurgical Transactions,' vol. xlviii, p. 232.

unusually large, and very high up; it had to be depressed in order to get room for the tube above it. The breathing was greatly relieved by the operation; no membrane was got up or seen at the time. At the end of a week, the local and general condition being very satisfactory, I attempted to remove the tube, but on closing the tracheal opening found that little or no air could be passed through the larynx. There was hardly any pharyngeal complication. At the end of another fortnight I again attempted to remove the tube, with no better success. He was therefore chloroformed, and the larynx was examined as well as could be through the tracheal wound; a soft conical bougie also was passed down the trachea and up into the larynx without meeting any impediment either way on this occasion. In subsequent trials at dilatation of the glottis (which appeared to be the seat of the obstruction) with the conical bougie I found myself frequently unable to pass it through the glottis; it appeared to hitch at some spot, but I was unable to say why; at other times the bougie appeared to pass easily. On closing the tracheal wound and obliging the child to breathe through the larynx, it became evident that there was a serious impediment, for although a little air could be made to pass, it was only accomplished with great effort, and was quite insufficient in amount to sustain life. The laryngeal condition remained unaltered for upwards of three months, an effort being made from time to time to remove the tube, but without any success. The child's general condition appeared good; he looked fat and well. One night he was found dead in bed; no sound had been heard by the night nurse, who had just previously looked at him and found him sleeping comfortably; he was found with the bedclothes undisturbed, his eyes were closed, and his features free from any sign of a struggle. The results of the autopsy were quite negative as to the cause of death.

CASE 2.—A little boy, aged one year and ten months, when admitted into the East London Hospital with diphtheria for which tracheotomy had to be performed. The disease ran its course and subsided; the tube, however, could not be removed, and the boy was discharged from the hospital several months later still wearing his tube. Some time afterwards he was admitted into Great Ormond Street, while the Shadwell Hospital was closed undergoing repairs, and Mr. MARSH kindly took charge of him. The subsequent history of this boy I abstract from Dr. STEAVENSON'S interesting 'Notes on Tracheotomy' in the eighteenth volume of 'St. Bartholomew's Hospital Reports.'

"On admission under Mr. MARSH's care the opening of the larynx into the trachea situated above the wound was totally obliterated so far as the passage of air into the mouth was concerned; but a small probe could be pressed through the granulations into the larynx. These granulations, which blocked up the opening, were brushed every few days with a solution of perchloride of iron, and a probe was passed through the opening. Later on the probe was coated with nitrate of silver and introduced into the opening. After this treatment had been pursued for several months, the passage had so far enlarged as to readily admit the closed blades of a dilating forceps. But no attempt was ever made at speech. The child's general health continued excellent; he was allowed to run about the ward as he wished, and he became a general favourite, but he could never breathe satisfactorily without his tube. It was sometimes left out for a short time, but the child was in fear and dread until it was replaced. Often a fit of dyspnoea necessitated its re-introduction. As a rule, he wore one of Mr. MORRANT BAKER's india-rubber tubes; but often after the tube had been left out for a few hours, the wound had so contracted that a silver one had to be used to re-dilate it.

"On the evening of March 17th, 1881, the child was found dead in his cot. No sound had been heard by the nurse in attendance in the ward; the bedclothes were not deranged; there was no foaming about the mouth; the expression was calm; the tube quite clear; in short there was no evidence to show what had caused the child's death.

"On examination of the body twenty-one hours after death there was found marked enlargement of the circumvallate papillæ at the root of the tongue. The uvula and soft palate were thickened. The epiglottis was much swollen, the mucous membrane covering the arytenoid cartilages œdematous and pendulous. On opening the larynx, the whole mucous membrane was found much thickened and reddened, especially the false cords; the ventricles were patent; the true vocal cords could not be recognised. There was some constriction at the lower aperture of the larynx, but it admitted the passage of a goose-quill. The tracheotomy wound was partly through the cricoid cartilage. About an inch below this, on the anterior wall of the trachea, was a well-marked scar with some contraction"

CASE 3 was a girl about thirteen years of age, on whom I had performed tracheotomy for what appeared to be membranous laryngitis; the onset of the disease had been very sudden, and the symptoms of suffocation urgent. The girl seemed to be

doing well; there was a moderate amount of tracheal secretion, which came up without difficulty. On the evening of the fourth day after the operation, while having her tea, she fell back and died suddenly. The tube at that time was quite patent; the exact cause of death could not be ascertained.

CASE 4 was a little boy four years old. He died quite suddenly on the third day while playing with his toys, and shortly after his tea. In this case there had not been any of the asthenia which is so often a prominent feature in diphtheria; his tube was quite patent, and there was no disease in his lung.

In all these cases it is to be noted that death was quite sudden, and quite unlooked for. The breathing appeared to be normal until within a few moments of death; there was no struggling, and in those cases in which an autopsy was made nothing was found to account for death. As I have already said, I consider these deaths to be in all respects parallel with the sudden deaths (and many such are now recorded) which follow on opening or washing out, and sometimes simply on overdistension of the pleural cavity; they arise probably from a too powerful or too long-continued irritation of the peripheral branchlets of the pneumo-gastric nerves.

Foreign bodies.—The undetected presence of a foreign body near the glottis is sometimes a source of trouble after an operation which has had to be hurriedly performed, and in which the history of the cause and the mode of onset are not clear. In young children the diagnosis is often very difficult, for a laryngoscope can only seldom be used. Even when the history points to the presence of a foreign body as the probable cause it is not always possible to detect it. In this respect the following two cases are interesting. I had the opportunity of observing both, but they were not actually under my own care.

CASE. Sudden dyspnœa—No appreciable cause—
Tracheotomy—Death in convulsions—Autopsy re-

vealed the presence of a bit of eggshell in the larynx.—A small child was taken suddenly with laryngeal symptoms, and with urgent inspiratory dyspnoea, while playing about apparently in excellent health. It was brought to me shortly afterwards; the child was greatly distressed, breathing with difficulty, and sweating profusely in consequence; the angles of the mouth were drawn down at each inspiration. Tracheotomy was performed shortly after its return home, and gave perfect relief. A few days later attempts were made to dispense with the tube, but were quite unsuccessful. During one of these trials the child died in convulsions. At the autopsy a small piece of eggshell was found adherent to the side of the larynx.

CASE. Sudden dyspnoea—Fishbone suspected as the cause—Tracheotomy—Measles—Death—Autopsy—Impaction of bone in the glottis.—A little boy, aged eighteen months, was taken with sudden dyspnoea while or shortly after eating fish for dinner. The cause was immediately suspected, viz. that he had swallowed a bone. He was brought to the hospital, where a most careful search with the finger was made in the pharynx and upper part of larynx, but without success. Tracheotomy had to be performed. After its completion another search for the suspected bone was made, but with no better success. The boy did well after the operation, except that his temperature remained high. Frequent attempts to remove the tube were made; he could neither phonate nor inspire through the glottis. An attempt to see the larynx with the laryngoscope was also unsuccessful. A catheter could be passed into the mouth through the tracheal wound, but the child continued quite unable to breathe without his silver tube. About three weeks after the tracheotomy the child developed measles, which was very prevalent at the time, and died of lung complications. At the autopsy, the glottis was found quite closed with a long slender fishbone between the cords. The upper extremity of the bone projected into the pharynx.

These two cases are of interest as showing the difficulties which sometimes beset diagnosis as well as treatment. In such cases, the number of failures will certainly be lessened if feathering out the glottis at the operation, as advocated in a preceding chapter, be practised as a matter of routine in all cases. But whether this plan be adopted or not, it may be laid down as a canon of surgery, when

tracheotomy has been performed on account of a suspected foreign body, that the persistence of the symptoms points to a persistence of the cause.

Little is gained by procrastinating in such cases ; further treatment must be tried.

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